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## *INTERFERENCE IN WIRELESS TELEGRAPHY.*

On another page of this issue we publish an important paper upon wireless telegraphy, which was read by Dr. John Stone Stone before the electrical section of the Canadian Society of Civil Engineers on March 9. In this paper Dr. Stone discusses the conditions necessary for selective or non-interfering wireless telegraphy, and shows how the different elements of the system should be constructed in order that this end may be attained. The theory by which these conclusions have been reached is not easy to follow, unless one has made a special study of electrical oscillations. The results of the analysis, however, have been confirmed by experimental investigations, and it would seem feasible to obtain the conditions necessary for practical selectivity. Having attained selectivity, and with a range of frequency which will permit fifty or sixty stations to be operated within sending distance of each other, there would seem to be a wide field for the use of this system of communication. There is no question that messages can be sent great distances and received, provided the conditions are favorable; but unless any station can get into communication with any receiving station within its zone at any time, the use of the system must be rather limited. This condition can only be attained by selective operation, and it is in this direction that many workers have been striving. Dr. Stone has made noticeable advances in selective action by thorough and painstaking study into the complex theory and by elaborate experimental work. In his paper he points out not only the theoretical conditions most suitable for the receiving circuits, but he shows how the various devices themselves should be constructed so as to approach these conditions most nearly.

## *RETROGRESSIVE TELEPHONE LEGISLATION.*

Telephone rates in New York city, in one form or another, have come in for considerable discussion in the last few weeks, and at the present time there is under consideration at Albany a plan to abolish telephone tolls for talks from one borough to another. This apparently simple proposition involves some large and serious questions.

It is generally agreed that the advanced condition of the telephone industry in this city is largely due to a plan of rates, which, in a word, provides that each subscriber shall pay for what he gets, measured by the number of messages he sends and the amount of investment used in carrying such messages. The advantages and equities of such a plan over that of charging a lump sum per telephone, regardless of the number of messages sent, or the distance they are carried, are now very generally recognized. Even those well-meaning people who only a few years ago worked industriously for legislative action fixing so-called "flat" rates for the various communities which to-day constitute New York city, now perceive that had their advice been taken a serious mistake would have been made.

The bill now under consideration at Albany presents the "flat" rate idea in another form. It deals with areas instead of the number of calls, and only in this way differs from other flat-rate measures. The present city of New York was formed by incorporating into one municipality a number of separate communities. The plan of Senator Keenan, who fathers the bill in question, is to treat the vast area covered by New York city as one telephone district. There are to be no rates for service within any area less than the whole of this great city. Such rates, varying with the privileges offered, and in some cases as low as twenty-four dollars per year, have been the means of bringing the inestimable benefits of the telephone to a large number of people, but the advocates of Senator Keenan's

bill would change all this. No such rates are to be allowed, however much they may be desired by the public. It is to be unlawful to charge any regular subscriber an additional fee for a talk from one borough to another. Practically all must be on the same basis, and then it seems to follow as a matter of course that all regular subscribers must pay the same rates; otherwise there would be unlawful discrimination. The Keenan bill means all this if it means anything. A moment's reflection will show that, from the standpoint of the public, it is not a desirable measure. The lawmakers would do well to look at it twice before acting.

### *MUNICIPAL PLANTS AND RATES FOR ELECTRICAL SUPPLY.*

The outlook for electrical development in London is not very hopeful, for matters have been considerably confused by the number of requests made of Parliament for power to erect electrical supply stations, and by the stand taken by the municipal authorities there. The latter object to all bills which would enable private companies to extend their systems or erect new stations, although they themselves are not in a position to carry out the much needed development. This position taken by the municipal authorities leads one to examine the conditions of their plants in London, thus bringing to light some interesting facts.

It seems that the private companies in London have, on the whole, done a fairly successful business, although one or two of them have not done so well. On the other hand, the municipal systems have not done as well as the private systems. Indeed, on the whole they make a very poor showing. They have been able to add but little to their reserve and depreciation funds and, indeed, in some cases have been forced to draw upon these funds in order to pay running expenses. The report of the London County Council for the year 1902-1903 showed that, of thirteen municipal plants, there was but one which was able to make a reduction in the tax-rate. Four found it necessary to draw upon the taxes. Only three of these companies paid anything toward depreciation. Four payments were made to the reserve fund.

This condition leads one to enquire why, as a rule, the London municipal plants should be unsuccessful, while the private plants generally do a good business. Four reasons occur which may be suggested, any one of which might explain this result: first, the officers in charge of the municipal plants may be incompetent; second, the men who are responsible for the running of the plant may be dishonest; third, the men in charge, while both competent and honest, may unintentionally not devote as much attention to the details of operation and to keeping down the expenses as they should; fourth, the rates charged for the supply may be too low.

Taking up these four reasons, we may at once dismiss the first two, because we have no reason either to attribute to the officers incompetence or dishonesty; and, moreover, in attempting to draw any lesson from the London experience, these reasons could not be urged, since the reply could always be made that competent and honest men can be found. As for the third reason, it is not improbable that it will account, in part, for the unprofitable operation of municipal plants. Experience teaches us that we can not expect men whose positions are secure, and who gain nothing by improving the operation of their plant, to take as great pains and to devote as much time to improving every little detail as would men whose positions depend upon the results which they obtained, or who are financially interested in the system. This is a condition which may be expected in every municipal undertaking, and it should be reckoned with. It is not to be inferred that the men in charge are intentionally negligent. They probably do not realize that they are negligent.

The fourth reason suggested for the poor results shown by municipal plants seems to us to be the most important one. The only excuse for a municipal plant is that it reduces the expense of lighting the city or it supplies citizens at a lower rate than would be offered by a private company. Both of these excuses are apt to be urged, and for this reason the municipal authorities are likely to make the rates as low as they dare. If those who decide upon the charges which shall be made do not realize fully what it costs to operate a system, or how much they should charge against depreciation and maintenance, these rates are apt to be too low. An examination of the rates charged by the private and municipal companies in London would seem to show that this fourth explanation is the true one. The latest figures we have been able to obtain for the private companies are for the year 1903. The average of the rates made by eleven private companies operating in London was 9.44 cents per kilowatt-hour for private use. Six companies furnished some public lighting at an average rate of 4.74 cents per kilowatt-hour. The average of fourteen companies for both public and private supply was 7.94 cents. Compare these rates with those charged by the municipal authorities. The latest figures obtainable are for the year 1904, and these are for twelve London municipal plants. The rate for private supply is 6.9 cents per kilowatt-hour. The different municipalities charged themselves for public lighting at the rate of 4.62 cents, while the average charge for both public and private service was 6.21 cents per kilowatt-hour. This latter figure is nearly twenty-seven per cent less than the charge made by the private companies. If this rate were not less than that made by the private companies, the municipal authorities would save money by closing their plants and buying their supply. On the other hand, is it not chiefly because their rate is so much lower than that of the private companies that their financial showing is so poor? While the private companies have, as a rule, done a good business, it does not appear that they have made extraordinary profits. The city plants are not doing much more than paying their operating expenses, and are saving but little to be used toward paying for new machinery when it becomes necessary. The advocates of municipal ownership in this country are always telling us to look at what has been done in England, but we can not see that the results which we have quoted strengthen their position.

### CITY NOISES.

In his second report on the Chicago traction systems, Mr. B. J. Arnold takes up the question of reducing the noise of the elevated. He examines the causes of the present noise, suggests methods which, it is thought, will reduce them, and outlines a set of experiments for determining the best method of changing the structure of the elevated lines so as to reduce the noise as much as possible.

Briefly, the causes of the noise and the methods of reducing it suggested are as follows: first, there is the noise of the train itself; second, there is the noise due to the structure when it is set in vibration by the trains; third, there is the noise due to the special work and joints of the rail, where the passing of the wheels causes a blow on the track. To reduce these noises, first, the running gear of the trains should be in first-class order; second, it should be enclosed. To reduce the noise due to the structure, this should be modified so as to prevent its being set in vibration, and, to this end, something must be interposed between the rails and the structure which will absorb the vibrations, and not transmit them to the structure. The most satisfactory method of doing this is to interpose a stone ballast between the rails and the structure. This must be carried on a suitable floor. The ties rest upon the ballast. To reduce the noise of the track, a joint should be used which will not cause the hammering which is now universal. The noise due to special work should be reduced by removing all such work as is not absolutely necessary.

It is only recently that we have turned our attention toward reducing city noises. Heretofore we have been practically free to make all the noise we wished, if we did it at our work. A halt has been called only when we made a noise for amusement. It is, however, a good thing that this problem is receiving attention, although it has been taken up in but few cities as yet. There is altogether too much unnecessary noise in cities. Much of it might be reduced by using better methods and approved apparatus. A good deal could be reduced at but little expense. Mr. Arnold advises enclosing the running gear of the elevated cars. The same method might be used on surface cars. There is no doubt that it would greatly lessen the noise which these vehicles cause at present.

It is out of the question to reconstruct elevated systems. In fact, we are looking forward to the day when they will come down entirely—in New York, at least. But if Chicago finds it practical to reduce the noise at a not too prohibitive expense, other cities will probably follow it. Having done this, they may direct their attention to other sources of disturbance. While it is true that enclosing the running gear of an electric car might prevent the free movement of air through the trucks, it would not be difficult nor expensive to add suitable ventilating devices which would produce the desired effect, at the same time reducing the noise.

But our surface and elevated lines are not the only offenders in this matter. One of the most annoying is the early wagon or truck running over a stone pavement. These vehicles are most annoying in the early morning hours, when most of us are, or would like to be, asleep. There are the baker's wagon, the milk wagon, and those other vehicles which must make early morning trips. Why should not these vehicles use rubber tires? In fact, why should not all city vehicles use such tires? They would cost more, it is true, but they would reduce the noise wonderfully. They would make hauling easier for the horses, and they would greatly lessen the wear on the street paving. Practically all mechanically driven trucks use rubber tires, and we hope it will not be long before some such tire becomes universal on all city vehicles.

### SHORT-SIGHTED.

It was not very long ago that a fire broke out in a New York tenement, which resulted in a number of deaths because painters had been at work upon the house, and finding the fire-escape ladders in their way, had temporarily removed them. The result was a demand for instant inspection of all fire-escapes, to see that they were entirely adequate, in order that a similar accident might not occur again.

Some time later the awful accident happened in Chicago. As a result, all cities examined their theatres to see whether such an occurrence were possible at any of them.

Still later, disaster overtook New York in another direction. The *General Slocum* was burned, with a terrible loss of life. As a result of this accident, all our excursion steamers were overhauled, and, we hope, put in good condition.

Now again the to-be-expected has happened unexpectedly. A fire in a New York tenement caused several deaths; the fire-escapes were boarded up or so blocked with furniture as to make it impossible for the victims to escape by means of them. The result of this will probably be that all cities will see to it that fire-escapes are kept free and available for the purpose for which they are erected.

One of the most depressing things about these accidents is the fact that they concentrate attention upon one possible danger, and draw it away from others. We lock the particular door from which the horse is stolen, and leave all the others open. In other words, we are short-sighted, and we do not realize all that the lesson should teach us. We are like the school boy who learns his lesson by rote, and who can work out perfectly the particular example given in his text-book, but can not apply the principle involved to any other example. Eternal vigilance is the price of safety as well as of liberty, and we must learn that it is not enough to correct faults after they have proved their existence, but we must hunt for faults and make them right before they punish us for our negligence. If those whose business is to look out for such matters can not do all that should be done, they should have help. If the laws are not sufficient, they should be made so. Doubtless, it will be some time before this ideal condition can be reached, but we should aim toward it, and we ought to be nearer to it than we are to-day.

### *Charge Carried by the α Rays from Radium.*

The following interesting communication from Professor E. Rutherford, McGill University, Montreal, is reprinted from *Nature* (London).

No special difficulty has been experienced in showing that the β particles (electrons), expelled from radium, carry with them a negative charge of electricity. The positive charge left behind on the vessel containing the radioactive material is simply and strikingly illustrated in the arrangement devised by Strutt, which is now popularly known as the "radium clock."

Since the α particles are deflected by a magnet as if they carried a positive charge, it is to be expected that this charge should be easily detected; but all the initial experiments made for this purpose resulted in failure. Since there are four products in radium which give out α particles, and only one which gives out β particles, it is theoretically to be expected that four α particles should be expelled from radium for each β particle.

In the Bakerian lecture (Phil. Trans., series A, vol. cciv, p. 212, 1904) I described some experiments that were made to determine the charge carried by the α particles. About half a milligramme of radium bromide was dissolved in water, and spread uniformly over a metal plate and evaporated to dryness. With a plate of twenty square centimetres in area, the absorption of the α rays in the thin film of radium bromide is negligible. The solution of the radium released the emanation, and, several hours after removal, the activity of the radium fell to about one-quarter of its maximum value, and the β and γ rays from it practically disappeared. The experiments were made with the radium film at this minimum activity, in order to avoid the complication which would ensue if the β particles were present. An insulated plate was placed parallel to the radium plate and about three millimetres away from it. The apparatus was enclosed in an air-tight vessel, which was exhausted to a very low vacuum. The current between the plates was measured by an electrometer. The saturation current between the plates rapidly fell with decrease of pressure, but soon reached a limiting value—about one one-thousandth of the initial—which could not be reduced further, however good a vacuum was obtained. No certain evidence that the α particles carried a positive charge could be obtained. It was thought possible that the inability to reduce the current below this value might be due to a strong secondary radiation, consisting of slow-moving electrons, which were liberated by the impact of the α particles on matter. Strutt (*Phil. Mag.*, August, 1904) has also observed a very similar effect, using a plate of radiotellurium, which is well suited for this purpose, as it gives out only α rays.

J. J. Thomson (Proc. Camb. Phil. Soc., November 14, 1904; see *Nature*, December 15) has recently shown in a striking manner that a large number of slow-moving electrons are liberated from a plate of radiotellurium, although this substance is supposed to emit only α particles. These electrons could be readily bent back to the plate from which they came by the action of a magnetic field. No indication, however, that the α particles carried a charge was obtained.

I have recently attacked this problem again, using the methods and apparatus previously described, but, in addition, employing a strong magnetic field to remove the slow-moving electrons present with the α particles. The apparatus was placed between the pole-pieces of an electromagnet, so that the field was parallel to the plane of the plates. In such a case, most of the escaping electrons describe curved paths and return to the plate from which they set out. On application of the magnetic field, a very striking alteration was observed in the magnitude of the current. The positive and negative currents for a given voltage were greatly reduced. The upper plate, into which the α particles were fired, rapidly gained a positive charge. In a good vacuum, this was the case whether the lower plate was charged positively, or negatively, or connected to earth. The magnitude of the charge, deduced from these experiments, was found to be practically independent of the voltage between zero and eight volts. When once a magnetic field had been applied, of sufficient strength to stop all the slow-moving electrons, a large increase in its value had no effect on the magnitude of the positive charge. I think these experiments undoubtedly show that the α particles do carry a positive charge, and that the previous failures to detect this charge were due to the masking action of the large number of slow-moving electrons emitted from the plates.

Observations were made under different experimental conditions, and with very concordant results. In one set of experiments a weight of 0.19 milligramme of radium bromide was used, spread on a glass plate, which was covered with a thin sheet of aluminum foil; in the other 0.48 milligramme, spread on an aluminum plate. The saturation current due to the latter plate, measured between parallel plates 3.5 centimetres apart by means of a galvanometer, was found to be $7.8 \times 10^{-8}$ amperes. It is possible the failure of Professor Thomson to detect the positive charge carried by the α rays from radiotellurium was due to the smallness of the effect to be measured; for with the plate of radiotellurium in my possession, the current was only about one-fortieth of the above value.

Since the film of radium bromide is so thin that all the α particles escape from its surface, it is easy to deduce from the observed charge from a known weight of radium the total number of α particles expelled per second from one gramme of radium bromide. Taking into consideration that half of the α particles were projected into the radium plate, and assuming that the α particle carries the same charge as a gaseous ion, it was deduced that one gramme of radium bromide emits $3.5 \times 10^{10}$ particles per second. Now the activity of radium bromide in radioactive equilibrium is four times this minimum, and contains four products which emit α particles at the same rate. It is thus probable that one gramme of radium bromide in radioactive equilibrium emits $1.4 \times 10^{11}$ particles per second. I had previously deduced (*loc. cit.*), from indirect data, the value about $1.1 \times 10^{11}$, so that the theoretical and experimental numbers are in very good agreement.

I have also made experiments, by a special method, to determine the total number of β particles emitted from one gramme of radium bromide in radioactive equilibrium, and have found a value about the same as the number of α particles emitted at its minimum activity. It is thus seen that four α particles are expelled from radium for each β particle. The number of β particles obtained by Wien was much smaller than this, but, in his experiments, a large proportion of the more slowly moving β particles was absorbed in the radium itself and in the envelop enclosing it.

The number of α particles expelled per second from one gramme of radium is a most important constant, for on it depends all calculations to determine the volume of the emanation, and of helium, the heat emission of radium, and also the probable life of radium and the other radio elements.

### *Report on Methods for Increasing the Capacity and Reducing the Noise of the Union Elevated Loop, Chicago, Ill.*

The second part on the rapid transit situation of Chicago, Ill., has been made to the committee on local transportation of the Chicago city council, by Mr. Bion J. Arnold. This report consists of two parts, the first dealing with the problem of increasing the capacity of the present elevated loop. Four plans are suggested. A more extended study of the problem shows that an increase in capacity can not be obtained by the method of through-routing, as suggested in the first report. At the present time the capacity of the loop is limited by the station platforms, and not by the junctions, although the latter limit the number of trains which can be operated over the road. The first plan suggests a new system of through-routing which calls for some changes in the present structure. This plan provides for through-routing of any trains from any of the three main divisions of the city to any other division. It is thought, however, that this plan is not altogether desirable, and a second plan is suggested, which provides for a limited through-routing. This will increase the capacity of the loop about twenty-five per cent, but it will necessitate some passengers changing cars.

The third plan contemplates what is thought to be the best solution of the problem. It eliminates grade crossings by elevating the tracks of the inner loop over those of the outer loop at certain points, and allows the routing proposed in the second plan to be adopted, and it increases the capacity of the system 100 per cent.

The fourth plan suggested contemplates increasing the loop by removing the present Van Buren street structure to Polk street.

The estimated cost of the first plan is $97,000; of the second, $80,000; of the third, $500,000.

The following are the recommendations made: first, to reconstruct and elevate the system, according to the third plan; extend the platforms so that each will accommodate two trains, and develop auxiliary terminals. If it is impracticable to elevate the inner loop, it is recommended that plan No. 2 be adopted, platforms extended and auxiliary terminals developed. If this plan proves impracticable, then the loop should be left as it now is, but power mechanism should be installed for operating the signals and the switches, platforms should be extended and auxiliary terminals adopted.

The second part of the report deals with the problem of reducing the noise. Mr. Arnold first describes the various plans for deadening the sound, which have been proposed, and, in some cases, tried. The first experiments for this purpose were made in 1871 by the Manhattan Railway Company, of New York. The rail was packed with some sound-absorbing material, but the results were not satisfactory. When the New York Central & Hudson River Railroad Company completed its steel viaduct from the Harlem river to 110th street, New York city, in 1897, the rails, which had at first been bolted directly to the steel structure, were raised and placed on wooden ties which were then ballasted with crushed stone. This had the effect of reducing greatly the noise.

In 1893 the Liverpool Overhead Railway, of Liverpool, England, used a steel arch construction, which carried the ballast on which the ties were laid.

The latest attempt in this direction was made on the elevated electric railroad of Berlin. Here the ties are imbedded in ballast. On the outer sections of the road, the ties are placed directly on the I-beams of the structure. The use of ballast has greatly deadened the sound of the trains.

Were the present loop structure not in place, Mr. Arnold is of the opinion that a concrete structure could be designed, which would prevent, to a large degree, the noise now arising from the steel structure, and that the cost for the concrete structure would not be greatly in excess of the cost of the present structure. However, the fact must not be lost sight of, that the noise comes primarily from the trains, and a large part of this noise can not be eliminated entirely, no matter how good the design of the structure. As the noise due to the track arises principally from joints and special work, it is suggested that a mitred joint or a scarfed joint be adopted, and all special work not absolutely necessary for the proper operation of the trains be removed.

Since a large part of the noise proceeds from the running gear of the trains, it is important to apply some corrective for this, either on the cars or on the structure. Some method of enclosing the entire truck, including the wheels, with a light casing of sound-deadening, non-combustible material, such as asbestos sheeting, should be tried. This casing should come as close to the guard rails as practicable, and clear the third rails, so as to intercept as much of the noise from the wheels as possible. On one of the Chicago systems the trains are operated by means of a single motor car. It is suggested that this plan be abandoned and the multiple unit system be adopted, so as to reduce the duty on the individual gears, and thus reduce noise. All future cars should be equipped with trucks having as few parts as possible. Such cars as have no sound-deadening material in them should have hollow spaces filled with mineral wool or other light, non-combustible material. The relief openings of the triple valves of air brakes should be muffled. The cars should be inspected regularly, and all defective and worn parts promptly renewed.

Several methods by which the roadbed might be ballasted are considered. A wooden-ballasted floor is now in use on a section of the Boston Elevated Railway, with a marked effect in deadening the noise. Ballasted steel floors are objectionable, because they add to the amount of metal in the structure. This not only increases the noise due to the steel in the structure itself, but adds to the cost of painting and maintenance. A concrete floor, on the other hand, is free from these objections, but it calls for reenforcing the present structure. It is practically inelastic, therefore almost noiseless, and is proof against deterioration. It could be made up in sections in any convenient shop near the site, and erected in place as required. This would avoid all work in the field, except placing and setting. An objection to the solid floor is that it collects snow, but this is not thought to be serious. It also shuts off more light from the street, than does the present open structure. If a concrete floor should be adopted, it is suggested that concrete sides be extended up above the car truck, so as to enclose the running gear completely. This would aid greatly in reducing the noise.

It is recommended that if an elevated structure which would remove cross-overs and special work can not be adopted, that the structure be reconstructed according to a proposed plan, that it be reenforced at all junctions, and each junction provided with a solid floor ballasted with crushed stone or slag; that if this plan be impracticable, the junctions should be floored and ballasted; that sections of 300 feet each of the Market street terminal be equipped with different floors, and that trains be operated over these sections until the relative merits of the different types can be determined. When this has been done, the loop structure between junctions should be reenforced and the type of floor selected applied. In any event, it is recommended that the track and special work be reconstructed in accordance with suggestions contained in the report, and that the rolling stock and special work be maintained in first-class condition under rigid city inspection.

## THE DIFFICULTY WITH THE COMMUTATOR.

BY STANLEY S. SEYFERT.

The following is an example of the nasty difficulties which we meet with from time to time. I take opportunity to write about it because its solution has been very instructive.

We had just finished rewinding a twelve-kilowatt, six-pole, 110-volt direct-current machine. The armature winding was of the two-circuit type and four sets of brushes were used. The machine had previously been slightly damaged by fire, making new coils necessary.

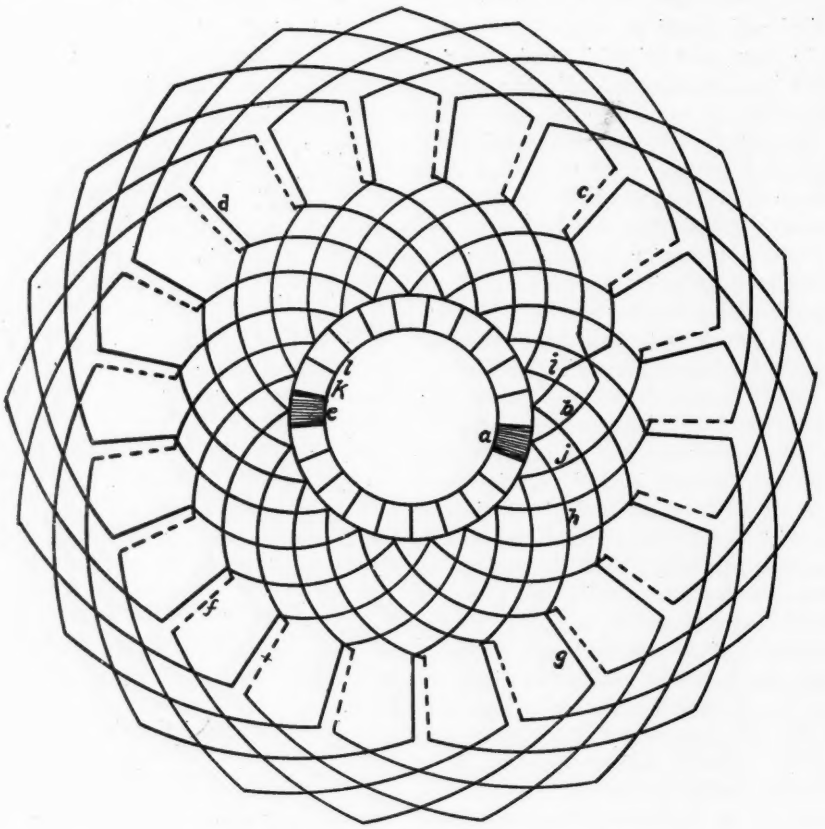
The ordinary starting rheostat was connected in the armature circuit for the trial run. On the first stud of the rheostat the motor ran slowly, but a bright spark was noticed to occur periodically at the edges of the brushes. Shifting the latter did not remedy this. Thinking that the sparking might disappear with increase of speed, I began to cut out the rheostat. The sparking neither increased nor diminished, but when the next to the last stud was reached the remaining coil of the rheostat became red hot, although the motor was running light and was no longer accelerating. Something, evidently, was wrong. Upon stopping the machine certain coils were found roasting. After marking the heated coils with chalk it was found that one course around the armature, consisting of three coils (six-pole wave windings), was the seat of the trouble.

At this stage I was almost certain that the fault consisted in the short-circuiting of two adjacent commutator bars by a lump of solder. The soldering had been done but a short time before; all the bars were carefully inspected and scraped wherever solder might have collected to form a short-circuit, but the trouble still continued to exist.

Thinking that the insulation of the commutator might be faulty I started out to locate the offending segments. I connected a rheostat and ammeter in series with 133-cycle, alternating-current mains and applied the two terminals to adjacent commutator bars. The comparatively low impedance offered to the flow of current by a pair of short-circuited segments would have been betrayed by a corresponding rise in the current. The ammeter gave a uniform deflection of eighteen amperes for each pair of segments until a faulty one was reached when the current dropped, accompanied by a flash across the insulation between the two segments. Although three segments, approximately 120 degrees apart, showed by their being burned and pitted during the previous run that they shared in the effects of the fault, the flashing before mentioned occurred between one and its two neighbors only. Furthermore, the flash occurred when the circuit was made, not when it was broken.

I now ordered the commutator to be turned off, but before this took place I tried the same test once more, when I found that the flash could no longer be produced and no current at all would flow when the terminals of the power-circuit were touched to a faulty segment and its neighbor, although eighteen amperes passed between any two normal adjacent segments. No other results were obtained by using direct current. In this way it was found that three segments with the corresponding armature coils were entirely insulated from the rest of the winding. Now there dawned on me a great light. Some coil must have been wrongly connected by the winder, but which one, and how?

The trouble had to be sought for in the lower layer of leads which were entirely out of reach and out of view. The mistake most liable to be made by the winder in this case would have been to interchange two adjacent leads. After making a diagram, something like the accompanying figure, I found that such an error would produce the effects before mentioned. The figure shows a wave winding for a four-pole machine in which the two leads *b* and *i* have been crossed. It is seen that this insulates segment *a*, segment *e*, and conductors *c*, *d*, *f* and *g* from the rest of the winding entirely, while the remaining coils form an ordinary closed wave winding. Of course, in case of the six-pole machine, there were three segments in the isolated circuit.

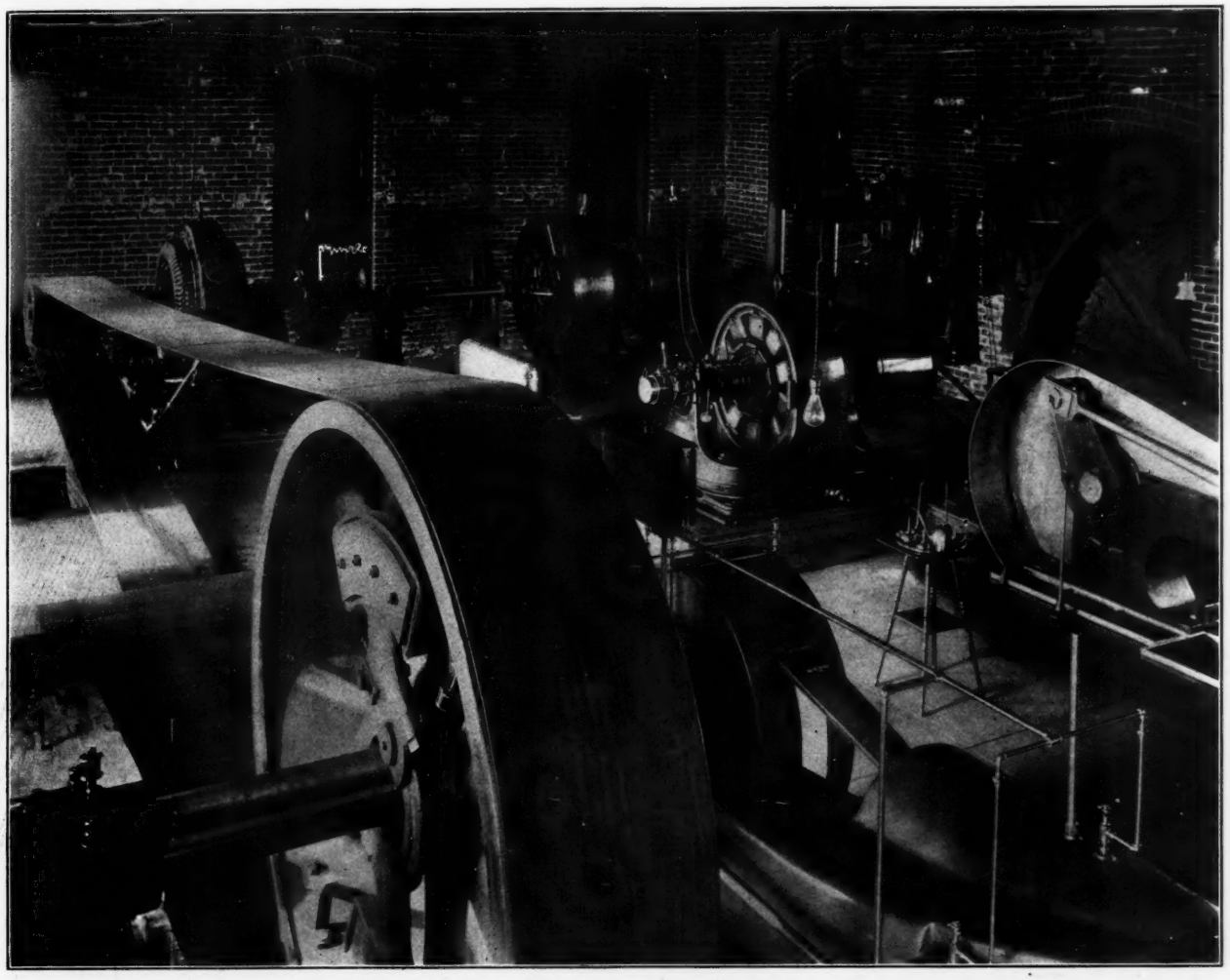



METHOD OF DISCOVERING FAULT IN COMMUTATOR.

It now remained to determine at which segment the mistake had been made. After counting the number of segments between the faulty ones, the intervals were found to contain twenty-five, twenty-three and twenty-two segments, respectively. The segment dividing the block of twenty-five from that of twenty-two was evidently the one sought. The upper lead going to this segment and the two adjacent ones were disconnected. The exact location of the fault was now determined by means of the magneto. The method may best be explained by means of the figure. If leads *i*, *b* and *j* be disconnected and one terminal of the magneto connected to *i*, the former will ring when the other terminal reaches *k*, nine segments ahead. In like manner, *b* will ring on *e*, eleven segments ahead; and *j* on *l* ten segments ahead. From this it is evident that *i* and *b* have been crossed and not *b* and *j*. We were able to recross the wrongly connected leads without disturbing any other part of the winding. The machine is now working perfectly.

# The Possibilities of the Small Central Station.

THERE are probably many small central stations scattered over the country that are only partially developed, and with a little study on the part of the management they could undoubtedly be vastly improved and their earning capacity increased to a very large degree. As an example of what this means, the developments of the central station at Mount Carmel, Ill., are of peculiar interest.

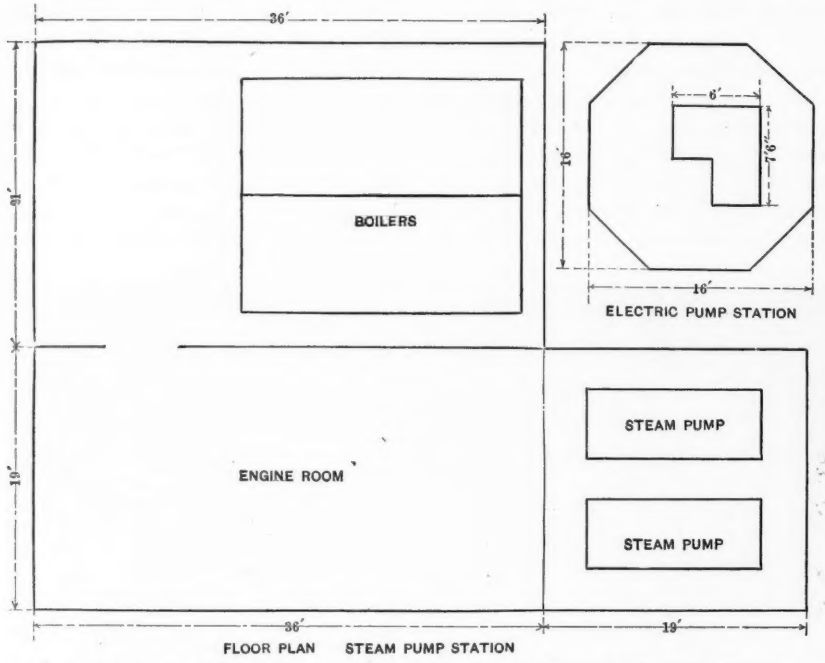


A View of the Power Plant of the New Electric Company, Mount Carmel, Ill.

This station was opened for business in 1893, and from that period up to 1902 the load was represented by 800 sixteen-candle-power incandescent lamps. In the early part of 1902, a new concern was formed under the style of the New Electric Company. This organization took over the old installation and immediately erected a new and up-to-date electric station. In the short period of two years, the load has been increased to 5,036 sixteen-candle-power incandescent lamps and a complete Helios-Upton series arc system supplying fifty-eight lamps for city lighting, with a day load consisting largely of single-phase motors of approximately 150 horse-power. The aggressive management of this new organization was not slow to further discover the inefficient operation of the city pumping station. Overtures were then made to the city council which resulted in its taking under its supervision January 1, 1903, for a period of twenty years, the duties formerly devolving upon this plant.

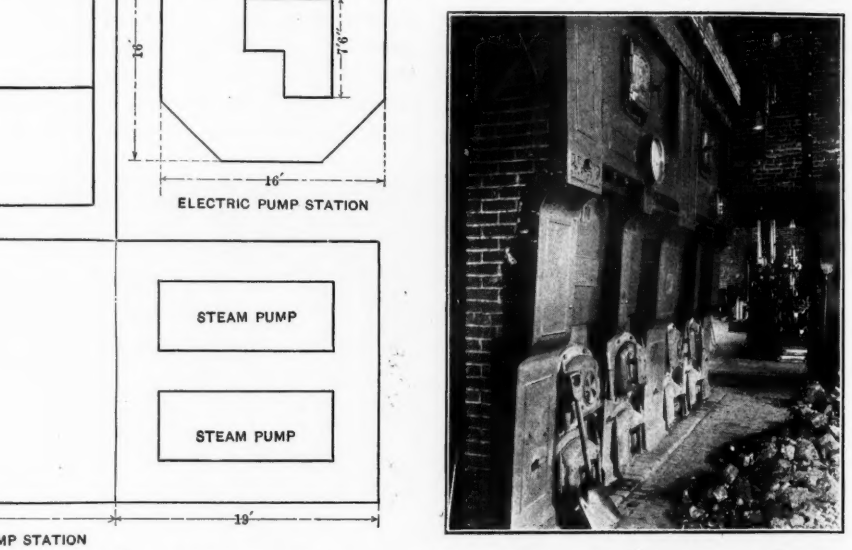
The old pumping plant consisted of a battery of two 42 inches by 16 feet tubular boilers supplying steam to two 8 by 12 by 8½ by 10 inch compound Deane pumps. During the first six months, the old steam plant was operated, and pumped 31,156,950 gallons of water at a cost of 6.6 cents per thousand gallons. Some decided changes were made in the operation of the plant, which enabled a reduction in pumping cost during the second six months to four cents per thousand gallons, 34,272,645 gallons being pumped during this period. During the third six months' period, the output was still further increased to 37,388,340, and the cost reduced to three cents per thousand gallons. At this point it found that it had reached the minimum cost possible with the steam pumping system as installed. The cost of slack coal delivered at this station was $1.40 per ton. This was due to the fact that the nearest railroad station is fully half a mile from the plant, and that coal must be hauled in wagons over roads that were almost impassable during the spring season. Realizing that the only way by which a greater economy could be effected in the operation of the pumping station was by the installation of new machinery, the old pumping plant was abandoned and a new pumping outfit installed, consisting of a 9 by 10 inch triplex

Deane pump, to which is directly geared a twenty-five-horse-power Wagner single-phase motor, operating from a 220-volt, sixty-cycle circuit, arranged to be practically operated automatically. The cost of this new outfit complete, including the motor, buildings, pumps, piping, etc., was $2,204.32. This new pumping outfit was installed in a pit underneath a new pump house, the diameter of the pit being sixteen feet. The walls are constructed of twelve inches of solid concrete, and owing to the difficulties periodically experienced from high water of the Wabash river, it was extended approximately ten feet above the bank of the river and about two feet above the highest recorded rise of the water in the river. One of the illustrations herewith shows the striking contrast between this new pump house and the older structure which required approximately five times the ground area occupied by the electric outfit.



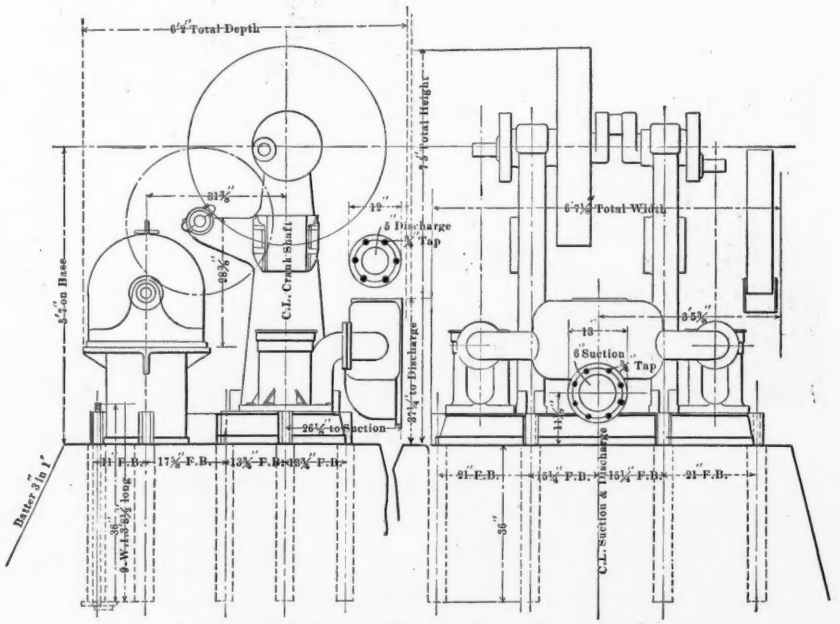

A Comparison of the Space Occupied by Steam and Electric Pumping Plant of Similar Capacity.

By the installation of this electrically driven pump it was enabled to dispense entirely with the keeping of a man at the pumping station and to further reduce the cost of pumping to 1.6 cents per thousand gallons, or practically twenty-five per cent of the cost per thousand gallons during the first six months of operation of the steam plant, and one-half of the minimum cost ever obtained by the use of the steam pumps. The pumping outfit is controlled from the central station, which is located about one-half mile distant, and it is enabled to do the pumping during the hours which, under other circumstances, it would not pay to run the lighting plant. By this arrangement it has been enabled to maintain a twenty-four hours' service and have a profitable day circuit during the entire year. Inspections of the plant are made daily, although it is capable of being operated over a considerable period of time without any further



Boiler Room of New Electric Company, Mt. Carmel, Ill.

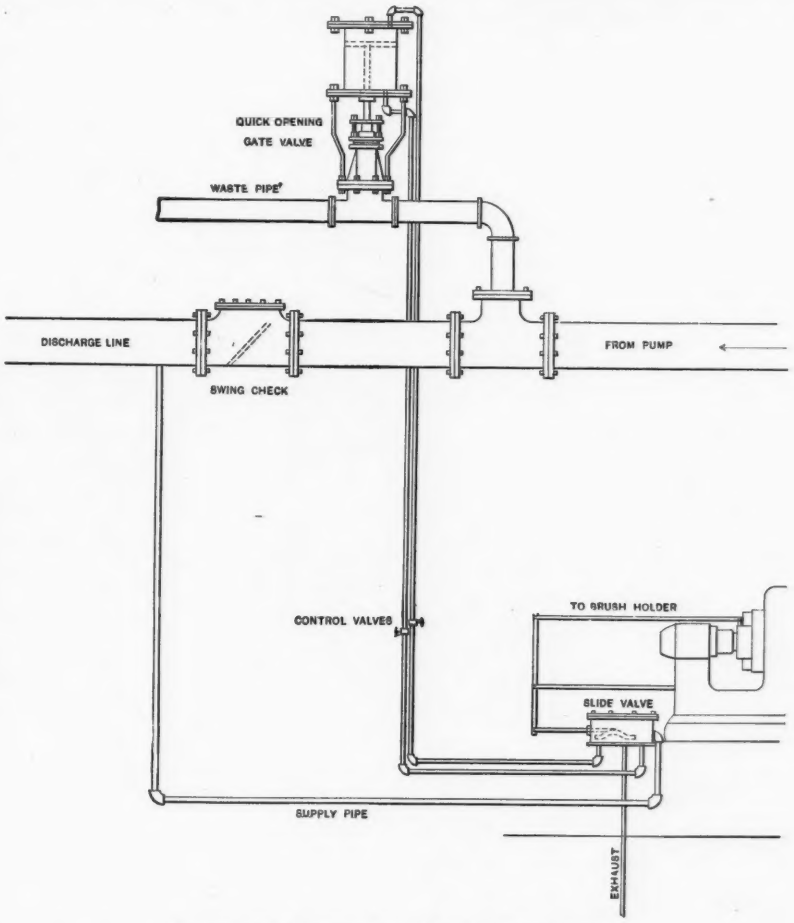
Exterior View of Power Plant of the New Electric Company, Mt. Carmel, Ill.




Dimensions and Setting Arrangements of Pump and Motor.

attention than that required for refilling of the various oil reservoirs.

The details of this pumping installation are shown in the accompanying diagram. The apparatus was designed to allow the single-phase motor to start without full load. Advantage was taken of the brush throw, which is peculiar to the Wagner motor design, to operate a small slide valve which in its turn admits water to either end of the hydraulic cylinder, controlling a quick opening by-pass valve. The operation of this mechanism is quite simple. Normally at rest, the brushes of the motor connect with the commutator of the machine, but as soon as the motor reaches its operating speed, the brushes are thrown out and it is by this action that the small auxiliary valve is opened through the medium of the lever referred to, which in turn operates hydraulically the valve in the main pipe to the reservoir. On stopping the pump, the valve is so arranged that the by-pass is open and remains open until the pump is started and gets well up to speed, at which time the by-pass slowly closes and remains closed until the pump is shut down. The speed of the closing of the by-pass valve is governed by the two small controlling valves placed in the pipes leading to either end of the hydraulic cylinder. This arrangement is clearly shown in the line drawings herewith. These drawings are not made to scale, the slide valve being shown proportionally much larger than it really is, the actual length being but six inches. The connecting pipes used to operate the valves are one-quarter inch, except the supply pipe, which is three-eighths inch. The




CONTROLLING DEVICE FOR MOTOR-DRIVEN PUMP.

THE OLD AND THE NEW PUMPING PLANT, MT. CARMEL, ILL. THE OLD PLANT THE FRAME BUILDING IN CENTRE, THE NEW PLANT AT EXTREME RIGHT.

company states that the arrangement has never given a moment's trouble, having worked perfectly at all times notwithstanding that it has been overloaded to the extent of more than twenty-five per cent. The distance from the pump to the reservoir is something over a mile, and the head against which the pump must operate is 185 feet.

To again revert to the new central station, the main building is of brick thirty feet wide and eighty feet long, and is located on the tracks of the Big Four railroad, a siding extending directly to the boiler room. Two 150-horse-power Stirling boilers supply steam at 150 pounds pressure. The boiler room auxiliaries consist of one 300-horse-power Cochrane feedwater heater and two National boiler feeders 7 by 4 by 9 feet. The coal used is Illinois pea and slack, ranging in price from eighty cents to $1.10 per ton delivered in the boiler room, which has a siding connected with the main line of the Big Four tracks. The power units consist of a Lane & Bodley 14 by 42 Corliss

engine, operating at eighty revolutions, which is belted to a jack shaft, from which in turn a ninety-kilowatt Westinghouse, single-phase, sixty-cycle generator is operated at 780 revolutions per minute. A Russell 18 by 18 automatic engine, operating at 900 revolutions per minute, is direct-belted to a Bullock 150-kilowatt, two-phase, sixty-cycle generator operating at 900 revolutions per minute. The primary voltage of the line is 2,200. The switchboard is made up of three panels, one being a combined arc and generating panel, one motor panel and one main generating panel, so arranged that any part of the load, or all of it, can be thrown on either generator, or any part on each generator, thus enabling the company to operate arcs, motors and incandescent lamps from the same machine, or to shift any part of the load to balance the two-phase circuit of the Bullock generator. Wagner volt and ammeters and G. I. oil switches are used in controlling the circuits.

OFFICE OF THE NEW ELECTRIC COMPANY, MT. CARMEL, ILL. METER TEST BOARD IN BACKGROUND.

Two of the Helios-Upton regulators are used, one of twenty-five and the other of thirty-five-light capacity. The city lighting is accomplished at the present time by fifty-eight 6.6-ampere series enclosed street lamps of the Helios-Upton type. The maintenance cost of these lamps, including carbons, inner globes and trimming after 120 hours burning, has averaged $1.89 per lamp. The interior of the power-house throughout is a model of neatness and speaks volumes for both the management and the operating engineer. Eighty-five per cent of the total load of the station is sold on a meter basis, while fifteen per cent is still disposed of on a flat rate basis, which was in vogue under the old management, and contracts for which have not yet expired.

Among the various industries served by the day circuit are a brick-yard one mile distant from the plant, using a thirty-five-horse-power motor for driving a pug mill; a packing house one and one-half miles distant from the plant, whose machinery is driven by a twenty-horse-power single-phase motor; a printing plant one-half mile distant from the station, driven by a three-horse-power motor, and an ice cream factory three-quarters mile distant, operated by a three-horse-power motor. Besides these installations, there are ten other concerns using motors ranging from one-half to two-horse-power. All of these machines are the product of the Wagner Electric Manufacturing Company, of St. Louis, Mo., and are said to be extremely satisfactory both as regards their efficiency and the lack of disturbance of the line voltage. Upward of 100 desk and ceiling fans are supplied in the business district of the city.

The good business methods of the New Electric Company are further reflected in the office of the company, a view of which is also shown herewith, and in the systems employed in its accounting department.

The panel-board shown in the background of the photograph of the office, is for the purpose of testing meters. This is a great convenience, as the work of testing a meter has been so simplified that it can be done by an inexperienced person after a few moments' instruction, and in this particular instance, the work is done by one of the stenographers in the office. A meter constant sheet is mounted upon the board, from which all of the necessary data for quick computation can be obtained. The work of the accounting department has been brought to a very accurate and simple basis, and this system has effected a great saving in time and also increased the accuracy of the work of the office force.

## *The Conclusions of the Niagara Power Commissioners Regarding Niagara.*

The Ontario Power Commission, in a statement recently issued, estimates the total available power at Niagara as 5,500,000 horse-power. The total amount of chartered power is 675,000 horse-power, or twelve and one-half per cent of the total available. The 375,000 horse-power already in process of development by the three Canadian corporations was considered to be largely in excess of all demands in Ontario for some years to come. The city of Toronto consumes in its lighting, electric railway and manufacturing plants only about 30,000 horse-power. If the average cost of power to consumers in Ontario is placed at, say, thirty-five dollars per horse-power per annum, the saving due to the use of electric power generated by different water-power companies may be taken at twenty dollars per horse-power per annum. With a consumption of 150,000 horse-power, the net annual value to Ontario consumers of power developed and sold at cost is $3,000,000, which, capitalized at four per cent per annum, represents a capital value of $75,000,000.

The possible courses open to municipalities in relation to power development are: first, independent development at Niagara Falls and elsewhere, to satisfy the needs of communities; second, acquisition of some one of the three existing undertakings at Niagara Falls; third, the purchase from existing corporations of power (*a*, delivered to consumers; *b*, delivered at sender's power-house subject to transmission at the cost and risk of the municipalities); fourth, the acquisition of available power sites to hold against future contingencies.

## SOME POINTS ON THE SELECTION OF ELECTRIC CABLES.[1]

BY L. B. ATKINSON AND C. J. BEAVER.

The specification of any standard conductor should state the effective sectional area of the whole conductor, *i. e.*, the area of a solid wire having the same conductivity, and the number of wires in the strand, or alternatively, as is common in the case of small conductors, the gauge number, or diameter in mils of the wire, and the number of wires in the strand.

It should further define the minimum conductivity allowable. In the case of tinned wires, it should also state the percentage permissible departure from the standard of conductivity produced by the tinning.

Every engineer knows the enormous difference in conductivity between pure copper and copper containing small percentages of impurity, but in few cases, especially with the smaller conductors bought commercially, is this tested, and there are copper conductors on the market of not more than eighty per cent (Matthiessen's standard) conductivity, and these are accepted and used for house wiring and other purposes without discovery. It can not be claimed that such wire is bought by the manufacturer as high conductivity copper, for there is no difficulty in obtaining electrolytic copper of from ninety-nine per cent to 102 per cent conductivity.

Cases have been known in practice, where imperfect conditions in the tinning process have resulted in a variation of as much as twelve per cent in the conductivity of 20 S. W. G. wire.

Rubber-insulated cables were the first cables used and their use to-day is still very large for all purposes where high insulation and easy fixing and manipulation are primary considerations. Speaking generally there is hardly any article of general commerce in which the buyer places himself so largely in the hands of the seller, as he does in the matter of india-rubber; and although large buyers often have facilities for the analysis of goods, there are difficulties in the analysis of india-rubber articles which are hardly paralleled in other general analytical work.

Conductors—In rubber cables the copper conductors should always be tinned. It is a matter of common knowledge to those who are at all familiar with rubber goods, that oxidation is the form of deterioration to which rubber is most liable; and to a greater extent with pure than with vulcanized rubber. Now the chief office of the pure rubber layer in a vulcanized rubber cable is to prevent the sulphur in the compound rubber from attacking the conductor. It is a chemical fact that copper is a powerful carrier of oxygen, and that it will readily part with its oxygen to a substance which has a great affinity for it.

Thus we have (for certain electrical reasons) in close proximity in a rubber cable two substances, rubber and copper, which for chemical reasons should be kept apart. The coating of tin on the wire acts as the necessary separating medium, and it is obvious that its efficient application is of the greatest importance.

Until recently, specifications hardly referred to this matter at all. There is now a marked tendency to ensure reasonable efficiency and uniformity, by specifying a definite test of the tin coating. The standard test, which is known as Glover's test, is now being used by the largest makers of tinned wire in this country and abroad; it was devised by one of us in 1897, and has been in daily use for the past seven years.

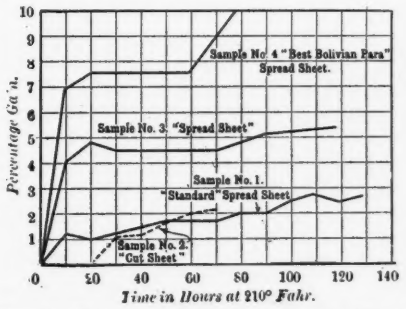



FIG. 1.—DIAGRAM SHOWING RATE OF OXIDATION OF VARIOUS PURE SHEET RUBBERS.

Pure Rubber—This should consist of absolutely pure rubber, without admixture of any kind. Pure hard fine Para rubber sheet is chiefly prepared by what is known as the "spreading method," in which the requisite mechanical and other properties are attained by "ageing" (hanging in dark rooms at a certain temperature) for several months. With raw rubber in the neighborhood of five shillings and threepence per pound, the cost to the cable-maker will be about eight shillings and sixpence per pound, though at the present time rubber strip, purporting to be pure Para, is being offered at five shillings and ninepence per pound. There is, therefore, little occasion for surprise to find that in foreign cables, and in cables made by firms with little or no reputation to support, the pure rubber, as above described, is replaced by a lower grade rubber, in which the requisite elasticity and mechanical properties are obtained by vulcanizing by what is known as the "cold cure" method. This consists of treating the surface with chloride of sulphur in carbon bisulphide. Apart from the fact that this rubber contains sulphur, contrary to the essentials of its functions in the cable, it nearly always contains traces of hydrochloric acid as an after result of the chemical treatment. The danger of using such rubber hardly needs emphasis, but the temptation to the small maker lies in the fact that it can be produced at something like forty per cent less cost than pure Para strip, made by the best method.

In some cases of cheap cables the pure rubber may be found to contain a proportion of "rubber substitute," which usually consists of oxidized or vulcanized oil, sometimes with an addition of wax. Such adulteration is not only fraudulent, but almost as harmful as the low-grade chemically treated rubber referred to above.

Where no attempt is made to adulterate, it is sometimes found that makers attempt to imitate the hard non-adhesive surface of correctly "aged" strip, by coating with a film of soapy composition. Wires coated with such rubber will blacken before vulcanizing if traces of free alkali are present.

Even in pure rubber strip, made solely from fine Para rubber, appreciable differences in the tendency to oxidize may be noticed.

The diagram shown in Fig. 1 illustrates the rate of oxidation of various makes of pure rubber strip. The curves show the results of ageing tests, which were carried out by exposing weighed quantities of the finely divided pure rubber to the atmosphere continuously at a temperature of 210 degrees Fahrenheit; precautions were taken to expel all traces of residual solvent and surface moisture before the actual experiments were commenced.

It will be seen that sample No. 4 oxidized most rapidly, and after eighty hours' exposure the finely divided particles were sufficiently oxidized to form a magma.

The same thing occurred with sample No. 2 at seventy hours, while samples 1 and 3 remained unaltered at 120 and 130 hours respectively.

It was found that the proportion of rubber resins in the various samples bore a well-defined ratio to the rate of oxidation observed.

Compound or Vulcanizing Rubbers—

[1] Abstract of paper read before the Institution of Electrical Engineers of Great Britain, January 31, 1905.

These are generally applied in two layers, that next the pure rubber being usually drab in color and the outer one, gray. They should have for their basis hard fine Para rubber, and should be vulcanized with a minimum proportion of pure sulphur, and mixed with mineral matter only to the extent required for the particular grade of cable which it is intended to produce.

The addition of rubber substitute, referred to under "pure rubber," should never be allowed; and the expression, "containing no organic matter other than rubber," is in some specifications intended to prohibit such materials.

In few cases are analyses made to check this important matter; even when the specification is framed to bar substitutes, large contracts are frequently placed without reference to anything of the kind, and the first-class firm has to be passed and orders given to possibly, a foreign competitor, who does not scruple to put in his "mixings," five per cent, ten per cent, or even more of a material costing anything from fourpence to one shilling per pound, in place of the hard fine Para costing from six shillings to seven shillings and sixpence per pound, according to the state of the market.

Such substitutes are invariably prejudicial to the life of rubber cables or any other rubber goods. They increase the liability to oxidation, because they only form mechanical mixtures, and neither combine chemically nor cohere physically; in fact, they subdivide the particles of rubber when ground up with it, and this means imperfect results as regards durability, from mechanical and from electrical points of view.

The admiralty moist heat test of 320 degrees Fahrenheit for four hours was designed to indicate roughly the presence of this class of adulterant, the substitute becoming partially saponified by the steam. Though only a rough test, it has answered its purpose fairly well.

Specifications frequently state the permissible percentage of mineral loading matter, or conversely the minimum proportion of Para rubber; but it will be readily seen that, in spite of specifications, the due performance of them is difficult of verification.

Consider, as an example, a specification issued not long ago for high and low-tension cables, involving some thousands of pounds; and note, notwithstanding its apparent exactitude, the loopholes that existed for variation therefrom. The specifications, as regards materials, ran as follows:

Low-Tension Cables—"Conductors to be of high conductivity copper, well tinned. The insulation to consist of pure and vulcanized rubber, the latter to contain not less than (X) per cent pure Para rubber, and the insulation to be not less than 1,250 megohms per mile."

The specification for extra high-tension cables was worded in a similar manner, with the difference that the insulation resistance was not specified.

The contract for these cables was sent abroad, British prices being far higher than those of foreign competitors. Analysis of samples of the dielectric supplied under the contract showed directly the reason of the discrepancies in the tender.

The general analytical results were as follows:

Pure Rubber—These contained "rubber substitutes," and the proportion of them varied from thirteen per cent in the best, to forty per cent in the worst sample. There were also indications that even the pure rubber which was present, was not fine Para, which those who draughted the specification no doubt wanted. One sample of so-called pure rubber contained over one per cent of sulphur.

Vulcanized Compound Rubbers—These contained rubber substitutes varying in quantity from five per cent in the best, to fifteen per cent in the worst, and although the results showed that the makers had kept within five per cent of the letter of the specification as regards the proportion of rubber to be used, there were signs that a rubber inferior to fine Para had been used, though, no doubt, the expression "pure Para" in the specification was intended to mean "fine Para," and not a rubber at little more than half the price (in the raw state).

Insulation Resistance—From the analytical results, it was plain to the authors that the specified insulation resistance could not have been obtained on some of the larger sizes of cable. It was ultimately found that difficulties in this direction had been evaded by the makers of these cables by taking the galvanometer readings after three minutes' electrification, instead of after one minute, which in the absence of anything stated to the contrary, is the accepted standard, and the difference in test at these two intervals would correspond with an approximate difference of insulation resistance in such cables in the ratio of one to three.

Extra High-Tension Rubber Cables—The specifications issued by engineers for extra high-tension rubber cables, usually state the proportion of Para rubber which the vulcanized rubber shall contain, the pressure test to which the cable shall be subjected in water (usually two or three times the working pressure), the insulation resistance per mile, and sometimes the radial thickness of the dielectric. Much greater care is necessary in making extra high-tension cables than in ordinary low-tension cables, because the working conditions have a tendency to create effects (such as electrolytic dissociation in the dielectric, and static discharge from the outer coverings of the cable and the consequent ozonizing effect) which are almost negligible at ordinary low pressures.

The former depends to a very great extent on the treatment of the rubber, and the selection and preparation of the loading materials which are used in conjunction with it.

The latter may be avoided to a very great extent by metallic braiding or lead covering. Otherwise there is always risk of a static discharge occurring from the usual fibrous outer coverings at local places which afford convenient paths for the same and which may cause local oxidation of the rubber and ultimately a breakdown.

Fire-Resisting Cables—Fire-resisting coverings are usually applied to "rubber cables," for the simple reason that rubber cables are chiefly used in situations where measures for the prevention of fires are most required. However, they may be just as efficiently applied to other types of insulation, such as V. P. or G. P., where the volatilization of the combustible constituents would cause fire to spread rapidly.

The fire-resisting properties can not practically be secured through any modification of the dielectric and must be attained by special treatment of the tapes, braidings, or lappings which form the usual mechanical protection to such cables. These fibrous materials may be chemically treated, so as to be absolutely incapable of supporting flame, and this treatment (under the process devised by one of us, used by Messrs. W. T. Glover & Company, Limited) is preferable, and for the sake of efficiency is applied to the yarns or fabrics before applying them to the cable.

Tanned jute is found to be the most suitable fibrous material for this purpose (though cotton, hemp, or flax may be used), and has at the same time the advantage of being mechanically strong, and

therefore not liable (as asbestos is) to succumb to vibration or rough handling.

During and after the process of lapping, braiding, etc., a suitable fire-resisting compound is served on to the coverings. Any degree of fireproofness can be attained by adding to the number of braidings or lappings. In practice, these are proportioned to the volume of inflammable material (*i. e.,* dielectric proper) in the cable, to the sizes of the cable, and to the particular class of work for which the cable is intended.

Imagine such a cable to be subject to the heat of a fierce flame externally for a prolonged period. After a lapse of time, dependent on the proportion of fire-resisting coverings to volatilizable materials (dielectric), the latter becomes softened by the heat, and ultimately decomposes and assumes the gaseous state. When the gases thus formed have accumulated sufficient pressure inside the cable, they force their way through the fire-resisting coverings, and burn on the exterior of the cable. But when the cause of the volatilization is taken away (*i. e.,* the external flame), the flame on the cable quickly disappears, and does not spread along the cable, as would be the case if the ordinary preservative compounds were used.

In the same way, if the source of heat applied to the cable is internal (an arc due to a breakdown of the dielectric, for instance), volatilization will proceed at the point of breakdown so long as the arc is kept up, but the resultant flame will disappear almost immediately the arc is stopped, because there is nothing on which the flame can feed.

Moreover, the flame due to the combustion of the volatilization products is not hot enough to ignite any adjacent cable having similar coverings, so that in every way the fire-resisting coverings tend to keep flame, arising from any cause, purely local.

| Dielectric from Cable. | Specific Gravity. | Ash. Per Cent. | Saponifiable Matter. Per Cent. | Unsaponifiable Matter (Org.). Per Cent. | Total Sulphur. Per Cent. |
|---|---|---|---|---|---|
| A | 1.076 | 7.0 | 76.2 | 12.7 | 4.0 |
| B | 1.31 | 34.7 | 18.0 | 45.1 | 2.1 |
| C | 1.15 | 18.27 | 30.0 | 47.5 | 4.2 |

Consider for a moment the behavior of an ordinary cable under similar circumstances. The preservative compounds burn readily, and the flame will rapidly travel along the exterior of the cable, thus continuously and increasingly causing the volatilization of the dielectric, the gases from which add considerably to the conflagration. Contrary to the case of the fire-resisting cable, the flames due to the preservative compound alone will readily ignite a similarly served adjacent cable.

Vulcanized Bitumen Cables—The early bitumen cables consisted of a wire coated with pure bitumen, but these cables were found to decentralize with more or less

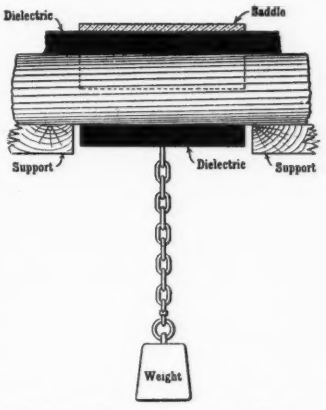



FIG. 2.—DECENTRALIZING TEST.

rapidity. Later, a cable was introduced by Messrs. Callender's Cable Company, under the name of "vulcanized bitumen," insulated with a material produced by sulphurizing a product of the distillation of certain oils, which has been very extensively used, and which alone or with other compounds forms the basis of several well-known insulating compounds.

The properties of some such cables may be considered by taking three examples of cables made by well-known cable-making firms, which will be referred to as

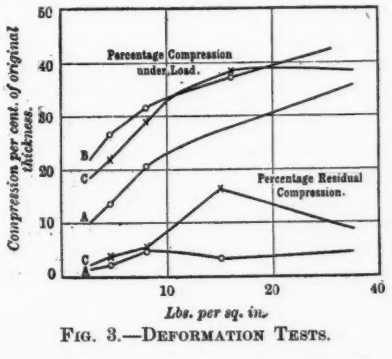



FIG. 3.—DEFORMATION TESTS.

A, B and C, of which the compositions were shown in the table in the previous column.

In order to find out how this class of cable behaves under various circumstances, a series of experiments was carried out by Mr. Bertram Blount at his laboratories in London, after consultation with the authors, and an examination of the lines of research carried out by one of them. The results are here incorporated.

In order to determine the tendency to decentralize in cables of this class, particularly at a moderately high temperature, short lengths of cable were loaded, the bare ends of the conductor being supported. The load was carried by a saddle across the cable, equivalent to one pound per lineal inch of cable as shown in Fig. 2.

The following table (2) shows the amount of decentralization which occurred after six hours in an air-bath at a temperature of ninety degrees centigrade equals 194 degrees Fahrenheit.

| Specimen. | Size of Cable. | Before Test. Thickness of Dielectric. | After Test. | |
|---|---|---|---|---|
| | | | Thickness. Upper Side. | Thickness. Lower Side. |
| A | Not tested | .... | .... | ... |
| B | 19/16 | .121 | .115 | .12 |
| C | 19/16 | .125 | .12 | .13 |

To determine more exactly the action of such compounds under load, bearing in mind that considerable weights of cable are often supported in a manner which concentrates the weight at one point, experiments were carried out to measure the deformation of samples of the material under definite loads, and the results are shown in Fig. 3. The upper lines show the percentage compression of the samples A, B and C under the various loads given by the abscissæ. The lower lines show for the same loads the residual deformation on removal of the load.

Sample B buckled when the load was removed, hence the permanent distortion could not be measured. These results show that with loads capable of very largely compressing the material, the elasticity is good; but they point out that with such materials some care must be exercised, by judicious design of methods of support, to avoid the localizing of supporting and other stresses.

The authors then took up the question of testing paper. The insulating material of the paper is extracted by some solvent, such as benzine. The paper is boiled in a weak alkaline solution, washed with water, and the fibres teased out with needles. These are then examined under the microscope. Several illustrations are given, showing the different character of various kinds of paper.

The materials used for impregnating the paper differ, but they should have the following characteristics: they should have the highest possible dielectric strength and specific insulation; the

specific inductive capacity should approach, as nearly as possible, that of the fibrous material; the compound should be plastic, but not fluid. The common test for this latter quality consists in cutting a piece of cable and suspending it vertically for a time, observing whether any of

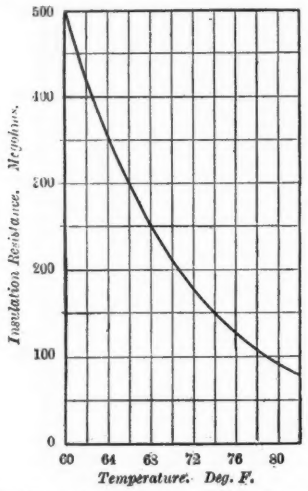



FIG. 4.—RELATION BETWEEN INSULATION RESISTANCE AND TEMPERATURE FOR PAPER-INSULATED CABLES.

the material flows back. The compound that will run out in this test will drain away from the cable at junction boxes.

As the final insulating property of these dielectrics depends upon the exclusion of moisture, a lead envelope is very important. In theory, the thinnest covering would suffice. Practice has enabled a certain thickness to be arrived at, which prevents any addition for protection against damage in handling and external corrosion. These thicknesses are shown diagrammatically in the accompanying figure. The thicknesses given there are taken as the minimum thicknesses, and, under certain conditions of soil and surroundings, it is advisable to increase them.

The lead is put on such cables in a plastic state by hydraulic pressure. This is an operation requiring such care to avoid minute cracks and damage from particles of oxide being forced in with the lead, that there are engineers who still advocate the older system of drawing the cable into a lead pipe which has already been tested by water pressure, or of putting on double sheaths of lead. W. T. Glover & Company, Limited, have, however, met the question by the use of hydraulic pressure up to 100 pounds per square inch applied externally after the cable is finished. Such pressure invariably detects a fault if such exists in the lead. The ordinary tank test is practically useless, and it may take many months or even years for water to enter the very fine seams which such faults occasion, but eventually it will do so.

Causes of corrosion due to impurities in lead, causing local galvanic action, are very rare. The total proportion of impurity shown by analysis of practically any brand of new soft English pig lead will not average more than 0.5 per cent. The only accidental impurity likely to get into the lead is oxide of lead, but the chances of this are very remote owing to improvements in the design of the melting-pot arrangements.

Galvanic action between lead and adjacent metal is also seldom met with, though one or two bad cases have come under our notice in concentric cables in which the lead has been applied directly over the outer conductor, and galvanic action has been set up between the tinned copper wires and the lead in presence of atmospheric moisture. The lead coverings were corroded through in about two years.

Corrosion by chemical action is fairly common, and may occur in certain soils or where organic acids are produced as the result of the decomposition of wood

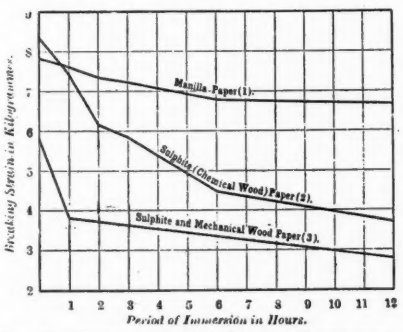

Breaking Stress in Kilogrammes.
Manilla Paper(1).
Sulphite (Chemical Wood) Paper(2).
Sulphite and Mechanical Wood Paper(3).
1 2 3 4 5 6 7 8 9 10 11 12
Period of Immersion in Hours.

FIG. 5.—EFFECT OF HEATING ON STRENGTH OF PAPERS OF VARIOUS COMPOSITION—IN OIL AT 310 DEGREES FAHRENHEIT.

or vegetable matter, or where cables are laid through made-up ground, especially where ashes or clinkers are abundant. Most pit waters have an appreciably corrosive effect on lead, some being extremely severe in their action, though we have known several cases where the water has been wrongfully blamed for damages really due to electrolysis.

Electrolysis is by far the most serious form of lead corrosion. Taking the word electrolysis in its broad sense—(*i. e.*, as the electrochemical action due to the passage—*via* an electrolyte—of current to or from the lead, which is in turn due to difference of potential between the lead and its surroundings from any cause)—it is also the most common form, though this is not usually appreciated.

So much has been heard for years past of the electrolytic corrosion of water and gas mains where electric tramways have been installed in various towns, that there is a tendency to disregard the fact that it may occur under conducive conditions even in isolated house wiring installations where lead-covered wires are used, neither tramway nor heavy lighting cables being near. The effect of the existence of a difference of potential between the lead covering of a wire or cable and its surroundings, depends on the degree of difference of potential, the current density in the electrolyte and the character of the electrolyte, *i. e.*, its conductivity, decomposition products, etc.

The character of the corrosion may vary from small holes which gradually penetrate the lead covering, converting the lead into various oxides of lead, and only make themselves apparent when the rubber dielectric becomes oxidized to a sufficient extent to break down, or the paper dielectric sufficiently exposed to absorb moisture and fail (which may take many months) to very extensive action and a high degree of oxidation (where there is a free and continuous supply of the electrolytic medium and a small difference of potential) or a limited amount of general corrosion, followed soon by fusion (where the supply of the electrolytic medium is small or not continuous, and the difference of potential is comparatively high).

To give instances of these varied conditions, and the varied character of the corrosion resulting from them, we may state in a general way that the first described result is most common in small and medium-sized lead-covered cables laid or fixed in wood casing (as occurs sometimes in large isolated installations) or

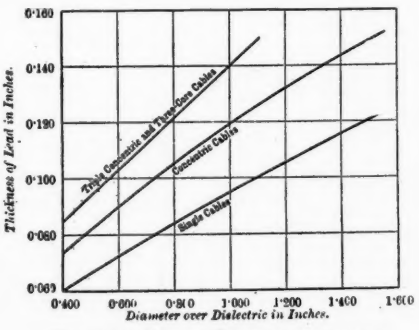



FIG. 11.—CABLE CHARACTERISTICS.

in conduits which are fairly dry or which do not actually have water running through them. The lead covering in such cases is only in intimate contact with the wood casing or conduit intermittently, and the corrosion naturally takes place chiefly at such places which are the paths of least

resistance. If such corroded points are carefully examined at various stages of the corrosion it will usually be found that a cone-shaped hole is eaten away and that the lead is converted into oxides, the various colors characterizing the degrees of oxidation being clearly distinguishable, the extreme outer layer becoming converted into the white carbonate by exposure to the moist atmosphere. In rubber cables the rubber usually fails quickly when the lead is finally penetrated, owing to oxidation of the rubber; but in the case of paper cables, if undisturbed, the oxides into which the lead is converted will keep out atmospheric moisture for, possibly, years, and the effect of the liberated oxygen on the paper (if made of pure manila only and well impregnated) will be negligible.

The second described action (where there is a continual supply of the electrolyte and small potential difference) chiefly occurs in conduits where water is continually trickling through; and in such cases the degree of oxidation is high and fairly uniform throughout the thickness and along the surface of the lead. The corrosion is practically confined to the bottom of the cable. The potential difference being low, and the surface exposed to the electrolytic medium being large, the current density will be very small, and therefore the final failure of the cable may take a year or two. The slowness of the action and the fact that the surface affected is more or less continuously covered with the electrolytic medium, accounts for the high degree of oxidation and the comparative absence of carbonate on the surface in such cases.

The third case, where a limited amount of corrosion is followed by fusion of the lead, generally occurs on large networks carrying heavy currents or on electric tramway and railway systems, where bonds may be fused by heavy leakage currents resulting from a short-circuit, whereby the lead coverings of cables may be raised to a potential difference of, say, ten to twenty volts. There may, under such circumstances, of course, be immediate breakdowns of other lead-covered cables, but in some cases the whole of the resultant damage may not be at once ascertained, and the consequent leakage currents may go on for some time, causing corrosion wherever lead coverings are even only partially exposed. (For instance, in the case of cables laid on the solid system imperfectly, or where the ends emerge into manholes, etc.) Supposing in such a case the electrolytic medium to be entirely decomposed and dried up by the passage of heavy leakage current (obviously at a high current density) sparking from the lead and fusion of the same may easily ensue.

It is not proposed here to touch further on the diagnosis of breakdowns due to lead corrosion. Enough has been written to indicate the extreme care necessary to avoid conditions which tend to produce lead faults, and incidentally to indicate that the use of lead-covered cables on large networks carrying heavy currents will probably be limited in the future, or that elaborate and costly precautions will have to be taken. It is obvious that bonding and earthing judiciously and sufficiently is the remedy for electrolytic faults, but in the first class of electrolytic faults, roughly and generally described above, bonding is frequently neglected. In the second class it is worthy of note that bonding and earthing, even if in accordance with Board of Trade regulations, is probably not a sufficient protection to prevent lead corrosion under the conditions referred to. In the third class it is fairly common for conditions to arise under which bonding and earthing arrangements, designed with a large margin of safety, are unavailing; and where very large currents return by earth paths as the result of breakdowns, it is almost impossible to forecast or predetermine what will happen on various parts of the network.

As a preventive measure against leakages of current from conductor to lead covering at connections in paper cables, where sealing boxes or terminals are difficult to fix, a waterproof non-fibrous sealing tape should be used, the tape being lapped over the trim from thimble to lead covering. Pure rubber, or even proofed tape, is often used on small cables by contractors, but is of little use under damp conditions, as either will absorb moisture in course of time, apart from the fact that they do not form a homogeneous covering. Instead of a covering of lead, a waterproof envelope of non-metallic material may be provided.

*(To be concluded.)*

## *Electrical Distribution in Paris in the Future.*

The technical commission appointed to consider the conditions affecting electrical distribution in Paris, and to draw up plans for future development, has made its final report. This is a long and detailed discussion of the various factors affecting electrical work in that city. The following, in brief, are the conclusions reached:

The most convenient plan for the distribution of electricity in Paris is one in which polyphase currents of high tension, at a frequency of fifty cycles per second, are produced in a number of stations placed in the outskirts of the city near the river Seine. This high-tension current will be transformed in substations, each serving a district. The distribution at the centre of the city will be by means of direct current on a 110 to 220-volt three-wire system. In sections less densely populated, alternating current at 110 volts will be distributed. Where special conditions obtain, and where the power consumed is large, or where it is very irregular, a direct transformation will be made.

The method of charging for the supply, which it is thought to be the only logical one, consists in adopting a formula which will make the price to every consumer directly proportional to the cost of furnishing him with the power. These rates will be based upon meter readings.

In carrying out this work it is necessary to adopt a plan which will provide for a period of transition extending over several years. The industrial sections must be looked out for first, and then other sections, according to their importance and the demand for power. During the transition the price must be regulated so as not to cause too great an increase in the demand.

The method of fixing rates consists of charging at a maximum rate of ten and one-half cents per kilowatt-hour for the first 400 hours. All over that will be charged for at the rate of 2.2 cents.

## *American Institute of Electrical Engineers.*

The next Institute meeting will be held on April 28, in the chapter room, Carnegie Hall, 154 West Fifty-seventh street, New York city. The following papers will be presented: "Polyphase Metering," J. D. Nies; "Notes on the Use of Instruments on Switchboards," F. P. Cox; "The Oscillograph and Its Uses," Louis T. Robinson; "Maintenance of Meters," W. J. Mowbray.

The annual meeting of the Institute will be held in the chapter room, Carnegie Hall, on May 16. The following programme is announced: Annual reports and election announcements; "Relays," George F. Chellis; "Circuit-Breakers and Oil Switches," E. M. Hewlett; "The Proper Limit of Duplication to Secure Reliability of Service," H. W. Buck.

The annual convention of the American Institute of Electrical Engineers will be held at Asheville, N. C., June 19 to June 23, 1905. Arrangements have been made for the presentation of the following partial list of papers: "Appalachian Water Powers," F. A. C. Perrine; "Three-Phase Traction," F. N. Waterman; "Coil Reactances," D. B. Rushmore; "Limits of Injurious Sparking in Direct-Current Commutation," Thorburn Reid; "A Study in the Design of Induction Motors," C. A. Adams; "Choice of Motors in Steam and Electric Practice," William McLellan; "High-Potential Oscillations of High Power in Large Power Distribution Systems," Charles P. Steinmetz; "Theoretical and Experimental Investigations on the Disruptive Strength of Air at Very High Voltages," Charles P. Steinmetz.

## INTERFERENCE IN WIRELESS TELEGRAPHY.[1]

BY JOHN STONE STONE.

### INTRODUCTION.

Of the various problems which have been presented in the course of the development of the new art of wireless telegraphy, none is of greater interest to the engineer and none is of more far-reaching importance from the industrial and commercial standpoint than that of rendering the receiving instruments of wireless telegraph stations immune from interference.

There are two principal kinds of interference.

1. Interference which arises from electrical charges which accumulate upon the vertical oscillator under various conditions of weather, provided the vertical oscillator has no adequate electrical connection to the earth.

2. Interference which arises from such stray electromagnetic waves as are produced by lightning, by magnetic storms, by sparks in neighboring circuits, such for instance as occur in trolley circuits, and also from the electromagnetic waves emanating from wireless telegraph stations other than that with which communication is desired.

### INTERFERENCE DUE TO STATIC CHARGES.

The interference which results from the first of these two sources is readily overcome since the oscillator of a wireless receiving station may always be given a metallic connection to the earth sufficient to maintain it clear of statical charges without in any appreciable degree interfering with its operation as a receiving oscillator.

Thus, for instance, if the vertical oscillator includes a condenser insulating a portion of the vertical oscillator from the earth, the condenser may be shunted by a coil of inductance so large that for the high frequencies employed in wireless telegraphy it shall operate practically as an open circuit, while affording a ready path to earth for the electrical charges which, in its absence, would accumulate upon the vertical oscillator and produce disruptive discharges to earth.

Again, if a highly sensitive detector or receiving device be included directly in the vertical receiving oscillator, such an inductance coil may be placed in shunt to the receiver without appreciably affecting its apparent sensitiveness. The coil will then serve as a by-path for the currents due to the passage of the charges of the vertical oscillator to the earth.

Another device which may serve to still further protect the receiver under these conditions is that illustrated in Fig. 1, in which V and V are portions of the vertical oscillator system, L is a coil of large inductance, R is the receiving device, and C is a condenser of capacity so large as not to impede appreciably the passage

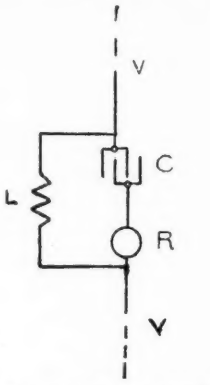



FIG. 1.—PROTECTIVE ARRANGEMENTS.

of the high-frequency oscillations of wireless telegraphy while acting practically as an open circuit for the more slowly varying currents by which the vertical oscillator is maintained free of static charges.

The greatest security from this form of interference is however obtained by providing the vertical receiving oscillator with an adequate conductive connection to earth and by placing the receiving device in a local circuit made resonant by a coil and a condenser to the frequency of the electrical oscillations to which the receiver is intended to respond.

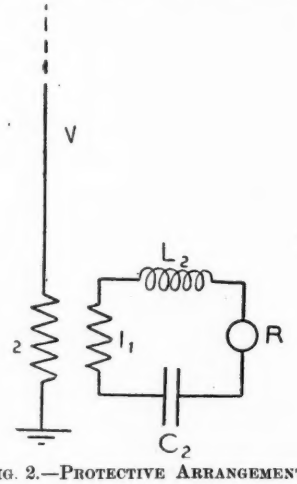



FIG. 2.—PROTECTIVE ARRANGEMENTS.

An example of such an arrangement is shown in Fig. 2, in which $VI_2E$ is the vertical receiving oscillator, $I_1$ and $I_2$ are the two coils of a high-frequency transformer, R is the receiver, $C_2$ is a condenser and $L_2$ is an inductance coil.

The manner in which the local circuit containing the receiver is made resonant to the frequency of the oscillations to which it is intended to respond will be considered later in this paper. It is sufficient here to note that the local circuit being resonant to a frequency sufficiently high for the purposes of wireless telegraphy will not be appreciably affected by the more slowly varying currents in the vertical oscillator by which the latter is maintained free from static charges.

### INTERFERENCE DUE TO ELECTROMAGNETIC WAVES.

Coming now to the prevention of interference by electromagnetic waves such as emanate from other wireless stations than that with which it is desired to hold communication, and to the prevention of interference by stray electromagnetic waves, we find that the solution of the problem depends upon the character of the message-bearing waves, the energy of which it is desired to convey to the receiving device, and also upon the character of the disturbing waves the energy of which it is desired to exclude or divert from the receiving device.

We can control the character of the waves whose energy we wish to receive, by suitably designing the apparatus to be used at the transmitting station, but we have no control over the character of the disturbing waves except in so far as these arise from wireless stations within operative range of the receiving station.

The simplest solution of this problem is to cause each transmitter to send out its signals by means of persistent trains of simple harmonic waves of a frequency materially different from that employed by any other transmitter within operative range of the receiving station with which communication is to be maintained and to make each receiver responsive only to persistent trains of simple harmonic waves of the frequency employed by the transmitter with which it is in communication.

By this means the system is rendered selective and becomes a multiple system of telegraphy, permitting the operator at each station to select the station with which he wishes to hold communication to the exclusion of all the other stations, and by which a number of messages may be transmitted simultaneously in a given region without interfering with one another.

Since the stray electromagnetic waves arising from lightning, etc., are not persistent trains of simple harmonic waves, but partake more of the character of isolated impulses, the receiver in such a sys-

[1] Read before the electrical section of the Canadian Society of Civil Engineers, Montreal, Canada, March 9, 1905.

tem does not respond to such stray electromagnetic waves and it is therefore also freed from interference which would otherwise arise from such sources.

The manner in which a transmitting station is made to develop persistent trains of simple harmonic electromagnetic waves of one frequency to the exclusion of waves

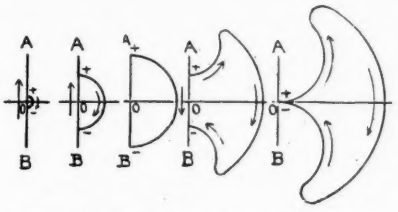



FIG. 3.—FREE ELECTRICAL OSCILLATION.

of other frequencies, though simple in itself, in practice requires the strictest attention to certain details, and these may be best understood by the consideration of a concrete case, this being the manner in which such problems are usually presented to the engineer if not to the inventor.

TRANSMITTER.

In modern wireless telegraphy the messages are transmitted by electromagnetic waves which are horizontally polarized at the earth's surface, and which are developed by electrical oscillations set up in an electrical oscillator whose axis is normal to the surface of the earth and which is connected to the earth at its lower extremity.

The reason for employing waves of this type and so developed, is that such waves have, at the earth's surface, no component of electric force parallel to the surface and no component of the magnetic force normal to or cutting that surface, except in the immediate neighborhood of the base of the transmitting oscillator. As a result they do not tend to induce currents in the surface of the earth as they travel away from the transmitter except where the surface of the earth deviates from the plane of polarization of the waves at that surface. The energy which would otherwise be rapidly dissipated through the production of induced currents in the earth is therefore conserved in the waves. Moreover, when a deviation occurs between the plane of the earth's surface and the plane of polarization of the waves at the earth's surface, the currents induced in the surface of the earth are such as to bend the wave front into a position normal to the surface with the result that the waves travel over and around mountains and in fact follow the earth's surface whatever be its contour, instead of tending to travel in straight lines like ordinary light waves and as would be the case with vertically polarized electromagnetic waves.

For a more complete exposition of these points see a paper read by the author at the International Electrical Congress, held at St. Louis, September 12 to 17, 1904, and reprinted in the ELECTRICAL REVIEW, New York, October 15, 1904.

There is not space in this paper to discuss in detail the development of the waves described above, but their genesis and mode of propagation are clearly suggested by Figs. 3 to 8. Fig. 3 and Fig. 4 illustrate the development of a wave by free electrical oscillations in a straight wire AoB, the curve lines indicating a line of electric force in its various phases from $t=0$ to $t=\frac{5}{8}T$, where T is the time of a complete free electrical oscillation in the wire. In Figs. 5 and 6 the genesis of a wave from a vertical linear oscillator. AO earthed at its lower extremity is illustrated, and in Figs. 7 and 8 the effect of an elevation and depression

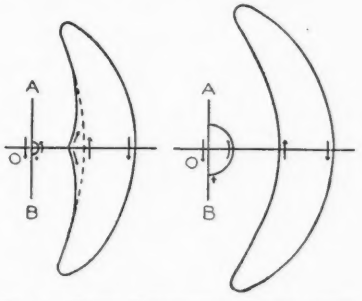



FIG. 4.—FREE ELECTRICAL OSCILLATION.

in the surface of the earth upon the wave fronts at that surface is indicated.

We may next consider the earth connection of the transmitting oscillator and the nature of the supports for the oscillator.

Although, by the use of such waves as are described above, normally the current density in the surface of the earth at a distance from the transmitting oscillator is rendered excessively small, nevertheless at and in the immediate neighborhood of the base of the vertical oscillator, the current density is in general very great. Moreover, since the current is of high frequency, it tends to flow only on the surface of the earth. For this reason the usual specifications for obtaining a good earth connection which involve burying a conductor of large area so deep in the ground that it shall be in permanently moist earth are no longer advantageous, and in a properly constructed wireless telegraph station the conductivity of the surface of the earth in the immediate neighborhood of the base of the oscillator is artificially increased by a superficial ground-plate composed of sheet metal, or of wire netting, extending radially from the base of the oscillator and covering as large an area about the base of the oscillator as is available for the purpose and consistent with reasonable economy.

Since the waves are horizontally polarized, the supports for the vertical oscillator, such as masts and guy ropes, should either be of insulating material, or if of metal, they should be divided by insulation into sections short compared to one-half the wave-length of any of the waves to be employed. The reason for this is that the fundamental free period of vibration of a linear conductor is such as to cause it to respond most energetically to waves of twice its own length. For such wave-lengths, therefore, the linear conductor would absorb an undue amount of the energy of the waves and moreover because of the rise of potential which occurs at the ends of the conductor for waves of such length it would be difficult to insulate the conductor from the earth or adjacent portions of the support of the vertical oscillator.

We come now to the vertical oscillator itself. This in general consists of two parts, the elevated conductor *per se* and the devices through which it is connected with the earth.

We shall here consider the relative simple case in which the elevated conductor is a straight, cylindrical copper wire of length $a$ and radius $\rho$.

Both theory and practice show that the electrical vibrations in such a wire connected directly to the earth at its lower extremity correspond very closely to the transverse vibrations of a heavily damped stretched string.

If such a wire be charged to a high potential and be then permitted to discharge to earth, the electrical oscillations developed in it, and therefore also the electromagnetic waves radiated by it, will not be simple harmonic in type and will not be

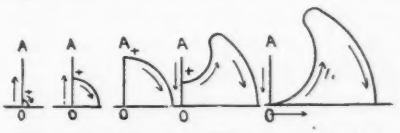



FIG. 5.—WAVE WITH VERTICAL LINEAR OSCILLATOR.

persistent. These waves will not, therefore, correspond to the sound waves given out by a tuning-fork, but will be of the character of those given out by a heavily damped violin string plucked at its centre.

The fundamental of the waves given out by such an oscillator has a wave-length which very closely approximates four times the length of the wire, and this is accompanied by all the odd harmonics.

The oscillations are so much damped by the energy drawn off from the oscillator by radiation as to make the resulting waves more nearly the equivalent of an impulse than of a sustained or persistent train of waves.

If, however, the elevated conductor be not directly connected to the earth, but be connected to it through an inductance coil, both theory and practice show that its electrical vibrations correspond to the transverse vibrations of a heavily damped stretched string with a mass attached to its centre.

The effect of the load at the centre of the stretched string and of the inductance at the base of the vertical wire is to increase the persistency of the vibrations, to minimize the importance of the harmonics and to lower the frequency of the fundamental. It might, therefore, seem that in order to cause the vertical oscillator in question to radiate a persistent train of simple harmonic waves of a predetermined frequency, it would be sufficient to charge the vertical wire to a high potential and permit it to discharge to earth through an inductance coil of suitable dimensions.

This, indeed, was the plan adopted in the first crude attempts to produce a selective system of wireless telegraphy. This method necessitates the use of waves of much lower frequency than that normally produced by natural vibrations in the vertical wire *per se*.

The degree of persistency of oscillations so obtained, however, is not as great as is required in practice. Such persistency as is obtained is gained at the expense of the amplitude of the current oscillations in the vertical and at the expense of the radiating power of the oscillator, the latter being *caeteris paribus* less for low than for high frequencies. Moreover, the spark in the vertical oscillator which normally dissipates an undue amount of the energy of the oscillations, has its resistance enhanced by the reduction of the amplitude of the current oscillations due to the presence of the inductance coil.

This latter difficulty may in a measure be overcome at the expense of any increase of the energy supplied to the oscillator, by shunting the spark gap by a condenser of large capacity. The discharge of the condenser across the spark gap increases the current through the spark and thereby reduces its resistance and damping effect upon the oscillations. The damping effect of the radiation still remains and the persistency is still too much limited for practical purposes.

So far we have considered only the natural oscillations of the vertical oscillator which are produced by charging the elevated conductor to a high potential and then permitting it to discharge to earth. When, however, a high degree of persistency, a pure sine wave and a great amplitude of oscillation are desired, the spark gap is removed from the vertical oscillat-

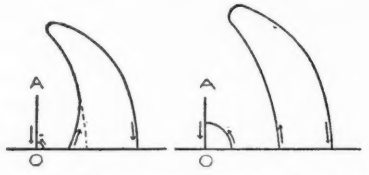



FIG. 6.—WAVE WITH VERTICAL LINEAR OSCILLATOR.

ing circuit and a simple harmonic electromotive force is impressed upon the vertical oscillator in its place. The resulting vibrations in the vertical oscillator are then forced simple harmonic vibrations. In order that they may be of great amplitude, the frequency of the impressed force is made to correspond to the fundamental of the vertical oscillator or to one of its harmonics, in which cases the reactance of the vertical oscillator is nil.

A simple arrangement for producing

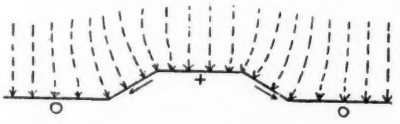


FIG. 7.—EFFECT OF ELEVATION.

forced, simple harmonic vibrations in the vertical oscillator is shown in Fig. 9 in which G is an alternating-current generator, K is a key, P shows the connection to the terminals of the primary of a spark coil, S is a spark gap between the terminals of the secondary of the spark coil, $C_1$ is a condenser, $L_1$ is an inductance, $I_1$ and $I_2$ are the primary and secondary coils of a high-frequency transformer, V is the vertical wire and E is the earth.

There is a variety of ways in which substantially the same result may be accomplished, but there is not space in this

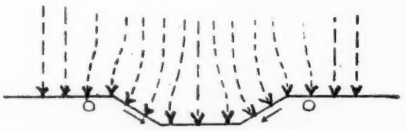


FIG. 8.—EFFECT OF DEPRESSION.

paper to consider more than one arrangement.

For the type of elevated conductor which we are here considering, *i. e.*, a cylindrical copper wire of length $a$ and radius $\rho$, the reactance of the elevated conductor *per se* is given with a degree of approximation ample for engineering calculations by the expression:

$$Z = -Lv \cot \frac{n a}{v}$$

where $L = 2 \log_\epsilon \frac{4a}{p} - k$

and where $k = 5.584 - 3.169 \left(\frac{n a}{v}\right)^2 + 0.3269 \left(\frac{n a}{v}\right)^4$ for values of $a$ between 0 and $\frac{\pi v}{2 n}$. [1]

In these expressions, $v$ is the velocity of light and $n$ is the periodicity of the impressed force or $\frac{2\pi}{T}$, where T is the time of a complete oscillation.

The reactance Z therefore vanishes when $n = \frac{2\pi}{T} = m \frac{\pi v}{2a}$, where $m$ is an odd integer. The wave-lengths corresponding to this condition are therefore $\lambda = v\,T = \frac{4a}{m}$. The wave-length of the fundamental is therefore $4a$ and the harmonics are all odd.

For frequencies lower than that of the fundamental, the reactance is negative or a capacity reactance. For frequencies between that of the fundamental and its first harmonic the reactance is positive or an inductance reactance. For frequencies between that of the first even harmonic and the first odd harmonic the reactance is again negative or a capacity reactance. In other words, the reactance of the vertical wire measured at the source or driving point of the system is either that of a condenser of capacity $S' = \frac{1}{L v n} \tan \frac{n a}{v}$ or of an inductance $L' = \frac{Lv}{n} \cot \frac{n a}{v}$ depending upon whether $\cot \frac{n a}{v}$ is positive or negative.

The condition for zero reactance in the vertical oscillator system is obviously $Z + Z_0 = 0$ where $Z_0$ is the reactance of the apparatus connected between the vertical wire and the earth. $Z_0$ must therefore be an inductance reactance for frequencies which make the reactance of the vertical wire a capacity reactance and conversely it must be a capacity reactance for frequencies which make the reactance of the vertical wire an inductance reactance.

The curve shown in Fig. 10 gives the observed apparent capacity of vertical wires 0.08 inch in diameter varying from

[1] The value of $k$ here given has been determined empirically, the remainder of the formula being based upon a theoretically deduced working theory described in the paper referred to. A more complete expression for L will be given elsewhere.

40 to 180 feet in length, when the periodicity of the impressed force is $9.78 \times 10^6$. In other words, it gives the observed apparent capacity of vertical wires for values the angle of $\frac{na}{v}$ from 0.3976 to 1.790 and for values of the ratio $\frac{4a}{\rho}$ from 47,520 to 213,800.

The reactance $Z_0$ of the apparatus through which the vertical wire is connected to ground may most simply be made negative, when this is necessary, by the insertion of a condenser in series with the coil $I_2$, but this result may be accomplished in a variety of ways, for the description of which there is not space in this paper.

It will seem that by making $Z_0 + Z = 0$ or $Z_0$ equal but opposite in sign to the reactance of the elevated conductor, powerful oscillations of any desired frequency may be developed in the vertical oscillator by means of forced vibrations, whereas when the natural oscillations of

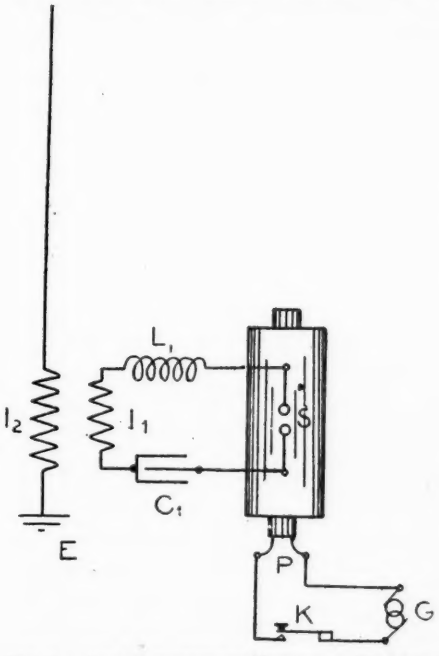



FIG. 9.—ARRANGEMENT FOR PRODUCING FORCED SIMPLE HARMONIC OSCILLATION.

the vertical oscillator are resorted to the frequency must necessarily be less than that of the fundamental of the oscillator.

Concerning the arrangement illustrated in Fig. 9, there is much of detail which requires attention in order that the apparatus shall satisfactorily fulfil the requirements of radiating a persistent train of simple harmonic waves. For instance, if a dielectric having considerable electrostatic hysteresis be employed in the condenser, a surprisingly large amount of energy will be dissipated in this dielectric. The magnitude of this loss is due to the fact that the energy dissipated increases both with the potential difference employed at the terminals of the condenser and also with the frequency. Since potential differences developed at the terminals of the condenser

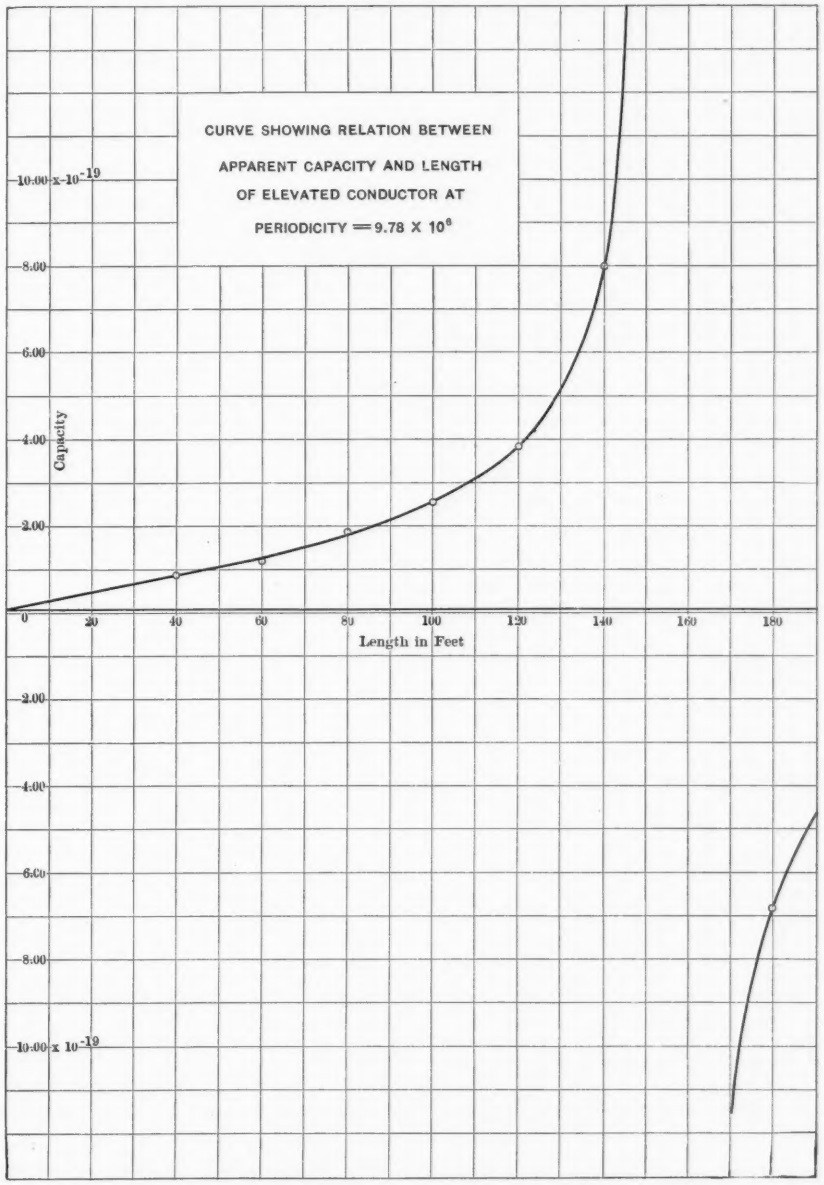



FIG. 10.—RELATION BETWEEN APPARENT CAPACITY AND LENGTH OF CONDUCTOR.

amounting to 50,000 volts and oscillations having frequencies of 5,000,000 are not unusual in wireless telegraphy, it is easy to see that the losses in the dielectric of a condenser in a wireless telegraph circuit are of a far greater order than that in the dielectric of condensers employed in the usual power or lighting circuits.

Moreover, the specific inductive capacity of most dielectrics is a function of the density of the displacement current in the dielectric, and when such dielectrics are employed in the condenser in an oscillating circuit the resulting oscillations are not simple harmonic in form and are not isochronous throughout the train.

Air condensers should therefore be used in wireless telegraphy to the exclusion of any other type pending the publication of the results of certain investigations which are being conducted with the view of supplying a dielectric of high dielectric strength and constant specific inductive capacity.

The coils used in wireless telegraphy should not have iron cores except the iron be very finely comminuted and imbedded in a non-hygroscopic dielectric matrix. It has even been found by the author that coils wound on a wooden cylinder do not operate satisfactorily when used in the oscillating circuits of wireless teleg-

raphy. The coils for this purpose are best constructed by winding a few turns of bare copper wire in a single layer on a skeleton frame made of ebonite, care being taken to separate the turns by such an amount that the sum of the air spaces between the wires of the turns is equal to or slightly greater than the sparking distance in air corresponding to the greatest potential difference liable to occur at the terminals of the coil when the apparatus is in operation.

If the local oscillating circuit $C_1I_1L_1S$ of the arrangement shown in Fig. 9 were isolated, its oscillations would be expressed by

$$i = \frac{e}{L}\left(\frac{1}{\sqrt{\frac{1}{LS} - \frac{R^2}{4L^2}}}\right)\epsilon^{-\frac{R}{2L}t}\left(\sin\sqrt{\frac{1}{RS} - \frac{R^2}{4L^2}}\right)t$$

where $i$ is the current, $e$ is the potential to which the condenser $C_1$ is charged at the time when the spark occurs at S, L is the inductance of the circuit, R is the resistance and S is the permittance or electrostatic capacity of the condenser.

If the oscillator is at all persistent $\frac{R^2}{4L^2}$ is negligible compared to $\frac{1}{LS}$, and the expression reduces to

$$i = e\sqrt{\frac{S}{L}}\epsilon^{-\frac{R}{2L}t} \cdot \sin\frac{t}{\sqrt{LS}}$$

The time required to fall to $\frac{1}{\epsilon}$ of their initial amplitude is therefore $t = \frac{2L}{R}$

The number of oscillations per unit of time is $\frac{1}{2\pi\sqrt{LS}}$.

For a given frequency, $Ln = \frac{1}{Sn}$ so that the persistency for a given frequency is proportional to

$\frac{Ln}{R}$, where $n$ is $2\pi$ times the frequency.

The measure of the persistency of the circuit is therefore proportional to $\sqrt{\frac{L}{R^2S}}$.

An isolated circuit of this type may be made to give extremely persistent simple harmonic oscillations, but if it be given a large coefficient of mutual inductance with another oscillator of relatively low persistency, such as the vertical oscillator $VI_2E$ of the arrangement shown in Fig. 9, two things happen. In the first place the oscillations of the circuit are in general no longer simple harmonic, but are broken up into two simple harmonic oscillations of different frequencies, and in the second place the persistency is greatly reduced.

To overcome this difficulty it is necessary either to make the magnetic leakage of the high frequency transformer, connecting the local oscillating circuit with the vertical oscillator, unusually large, or else to add to the local oscillating circuit an inductance coil $L_1$ with sufficient inductance to swamp by its effect the reaction from the secondary circuit.

When intense radiation is desired, it is necessary to make the capacity S of the condenser $C_1$ in the local oscillating circuit large compared to S[1], the apparent capacity of the elevated conductor *per se*, for the frequency employed.

RECEIVER.

Since the electromagnetic waves to be received at a wireless telegraph receiving

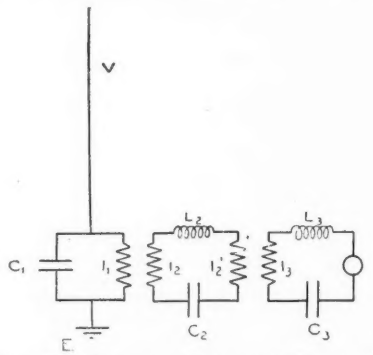



FIG. 11.—SELECTIVE RECEIVING CIRCUIT.

station are horizontally polarized at the earth's surface, an electrical oscillator whose axis is normal to the earth's surface is employed at the receiving station. This oscillator may either be connected to earth at its lower extremity or it may be connected to a device having reactance equal for all frequencies to the reactance of the vertical oscillator. It is to be remembered in this regard that at the receiving station we are not concerned with what becomes of the energy which is dissipated by the reradiation of the energy from the receiving vertical oscillator.

We shall consider again a simple concrete case, and shall assume the elevated conductor to be a cylindrical copper wire of length $a$ and radius $\rho$ as in the case of the transmitter, though it must by no means be assumed that the elevated conductor at the receiving station must necessarily be similar to that at the transmitting station, or, in fact, that it must bear any resemblance to that at the transmitting station except in so far as its axis is preferably normal to the surface of the earth.

As in the case of the transmitting station, only one simple arrangement of the apparatus sufficient to give the desired result will here be considered. By this arrangement messages transmitted by means of persistent trains of simple harmonic electromagnetic waves of a predetermined frequency may be received to the exclusion of messages transmitted by similar waves of materially different frequencies, and without interference by impulsive waves. Such an arrangement of the circuits and apparatus is shown in the diagram, Fig. 11. In this arrangement the receiving device which is indicated at R is placed in a local circuit $C_3I_3$ $L_3R_3$ which is made resonant to the frequency of the waves to which the station is intended to respond, and a second resonant circuit $C_2I_1$ $L_2I^2$ resonant to the same frequency and called a "weeding-out circuit," is interposed between the first mentioned circuit and the vertical oscillator.

The branch circuit, consisting of the coil $I_1$ and the condenser $C_1$, is not, when taken by itself, resonant to the same frequency as the other local circuits, but is so proportioned that when connected as a branch circuit, forming a part of the vertical oscillator system, the latter shall respond most energetically to persistent trains of waves of that frequency falling upon the vertical wire.

The way in which this is accomplished is perhaps more easily seen by a graphical demonstration than by the use of the analytical solution, though the latter is by no means difficult.

The curves in Fig. 12 illustrate the point in question. Curve 1 represents the reactance of the vertical wire measured at its point of attachment to the loop circuit, for varying periodicities of the impressed force. It will be seen that the periodicity of the fundamental of the vertical wire is at the point $n_1''$, where the reactance first vanishes. The first even harmonic is at $n_2''$, and the periodicity of its first odd harmonic is at $n_3''$, where the reactance again vanishes. Normally, therefore, curve 3, which is the current curve for varying periodicities of the impressed force on the vertical wire, would show maxima at $n_1''$ and at $n_3''$. The reactance of the loop circuit for varying periodicities of the impressed force, measured across the points of its attachment to the vertical wire and earth connection, is shown in curve 2.

The total reactance of the vertical oscillator measured at the earthed terminal is the algebraic sum of the two reactances shown in curves 1 and 2, and as a result the current curve 3 shows maxima, not at $n_1''$ and $n_3''$, but at periodicities $n$, $n''$ and at a periodicity slightly higher than $n_3''$.

These are the points at which the reactance of the loop circuit is equal, but opposite in sign, to that of the vertical wire.

The periodicity of the local loop circuit *per se* is $n_1'$ and for this periodicity the current in the vertical wire is practically nil.

The "weeding-out circuit" and the circuit containing the receiver are both resonant to the periodicity $n$, so that for persistent trains of waves of that periodicity the energy of the oscillations set up in the vertical oscillator is transmitted directly to the receiver, but persistent trains of waves of other frequencies, either produce but slight response in the vertical oscillator or else produce oscillations of the periodicity $n''$, or of a periodicity slightly higher than $n_3''$. To such periodicity the "weeding-out circuit" and the circuit containing the receiver are extremely irresponsive so that the receiving device receives but an inappreciable amount of the energy of the waves.

In the case of impulsive waves the vertical wire tends to respond only to its own natural rates of vibration as affected by the loop circuit, that is to say, it tends to oscillate at periodicity $n''$ and to upper harmonics. Such waves acting on the vertical wire, have little tendency to develop oscillations of the natural period of the loop circuit as affected by its connection with the vertical wire, namely $n$, and the receiver is therefore also protected from the effects of such impulsive waves.

All that has been said regarding the effects of electrostatic and magnetic hysteresis in the description of the transmitting station applies with added force to the apparatus at the receiving station. It is, in fact, much more important to exclude the effects of hysteresis from the receiving circuits than from the transmitting circuits, and it may be laid down as an important rule that under no circumstances shall solid or liquid dielectrics be used in the receiving circuits.

Moreover, the injunction in regard to making the mutual inductance small between oscillators at the transmitting station applies in the case of the resonant circuits at the receiving station, since if the mutual energies of the related resonant circuits be not small compared to their self energies, the resonant circuits will modify one another's natural periods and each circuit will respond to more than one periodicity.

Finally, it may be said that the measure of the selectivity of a resonant circuit is proportional to that $\sqrt{\frac{L}{R^2 S}}$, this expression being the same as that found in connection with the persistency of an oscillating circuit. For a given periodicity, therefore, the selectivity is proportional to $\frac{L N}{R}$.

So great is the selectivity of resonant circuits constructed of air condensers and properly designed inductance coils that there is no difficulty in adjusting such

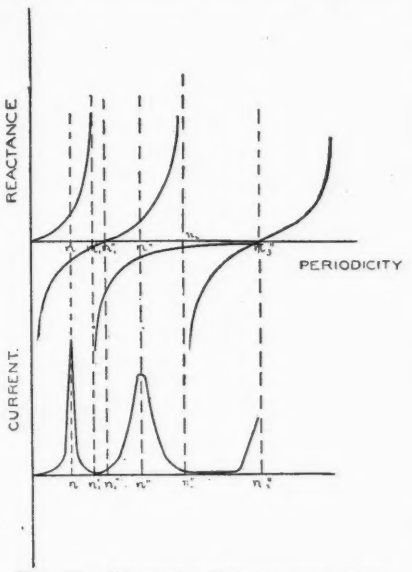



FIG. 12.—GRAPHICAL DEMONSTRATION OF SELECTIVITY.

circuits to resonance for a given frequency with an error of less than one part in 3,000.

The importance of the "weeding-out circuit" at the receiving station becomes apparent when we observe that the selectivity of the receiving vertical oscillator is greatly diminished by the dissipation of energy, which results from the reradiation of energy by that oscillator and that the selectivity of the resonant circuit containing the receiver may be greatly diminished by the energy absorbed by the receiver and utilized in its operation.

## *Electrical Tests on the Valtellina Railway.*

At the recent congress of the Italian Institution of Electrical Engineers, Signors M. Novi and A. Danoti presented a paper giving the results of interesting tests relating to the consumption of energy on the three-phase Valtellina Railway. It was found that the average consumption of energy required by a train running between Lecco and Sondrio, and between Colico and Chiavenna, ranged from seventy-seven to fifty watt-hours per ton-mile. The higher figure is for the consumption of a single motor car only. The lower figure is that obtained with a train which consisted of a motor car weighing fifty-four tons, and four or five trailer cars weighing from sixty to seventy tons. The stopping and starting points on these trial runs were made at the same altitude. A single motor car, when running at a speed of about thirty-seven miles per hour on the level, required 28.2 watt-hours per ton-mile. For trains of 110 and 130 tons, running at the same speed, the figures were 21.7 and 21.1 watt-hours per ton-mile, respectively. In accelerating a train up to 37.3 miles per hour, an expenditure of from ninety to 100 watts per ton of train-weight is required. Forty-two watt-hours are used in accelerating the mass, from eighteen to twenty-three watt-hours are used in overcoming train friction, while from thirty to thirty-five watt-hours are expended in the starting resistances or in motor losses. The time required for coming up to full speed is 130 seconds. There are seven stopping places between Lecco and Colico, a distance of twenty-five miles. In making this run about 9.7 watt-hours per ton-mile are wasted in starting resistances and in iron losses. This is about one-fifth of the average consumption per ton-mile. A train of 110 tons runs down a gradient of 0.417 per cent free. On steeper gradients, energy is returned to the line. A train of 120 tons on an incline of two per cent at a speed of twenty and one-half miles per hour, returned about forty-five watt-hours per ton-mile to the line. The motors, during this run, were connected in cascade. On other stretches of the line where the grades were less, though the speed was higher, practically the same energy was returned to the line. For instance, on a grade of 1.49 per cent, running at a speed of thirty-nine miles per hour, twenty-three watt-hours per ton-mile were returned to the line. From measurements of the energy supplied to the line by the power station it was found that, for a whole working day, lasting from four in the morning until twelve at night, 11,550 kilowatt-hours were consumed. The run during this time was 1,356 train-miles, or 161,000 ton-miles. This makes the average consumption per ton-mile seventy watt-hours, measured at the station. This figure covers the energy required for lighting and heating the train and the stations, and for driving the repair shops at Lecco, as well as for operating the trains.

A test of one of the new locomotives, recently acquired, showed that this could draw a train weighing 270 tons at a schedule speed of nearly forty miles per hour. The maximum gradient on this route is one per cent. At these points the locomotive draws from 150 to 160 amperes from the trolley wires. The voltage is 3,000. Trains weighing 460 tons have been run over the same line at about twenty miles an hour. On a two per cent grade it required from 190 to 200 amperes to start a train weighing 250 tons.

### *Planning New York Telephone Service for Twenty Years.*

[*From The Sun, March 19, 1905.*]

A phase of the New York Telephone Company's work of which the public knows little is a systematic endeavor to forecast from time to time the probable population in its various telephone centres. These forecasts are scarcely less important to the successful operation of the business than the manufacture of telephones or the laying of wires, for upon their accuracy hinges the financial profit or loss of the company.

In order to lay out the systems of subways properly, to locate the telephone central stations, to decide their number and size and to determine trunk line routes and cable crossings, it is necessary to forecast changes in the population likely to occur, not only in one, two or three years, but as far ahead as twenty years. For this reason the experts employed by the company have studied the development of New York in a way which has probably never been followed either in this country or abroad.

As a result the plans of the telephone company are now being made for the growth to be expected in periods as far ahead as 1925. The basis for most of its building operations now is a forecast for 1920, which was made by its experts in 1902.

Some idea of the material used in arriving at conclusions and of the methods by which the forecasters obtain results was gained the other day by a *Sun* reporter during a talk with the telephone company's chief engineer. Said he:

"We have found, as a rule, that the most reliable statistics concerning the growth of American cities are those given in the reports of the United States Census Bureau, and in making our forecasts these reports have been carefully studied and the past growth of the different cities of the United States analyzed and compared with that of New York. In addition to this the growth of London, Paris, Berlin and Vienna has been compared with that which has taken place in the large cities of this country.

"In figuring out our 1920 forecast we decided to estimate the population of the territory within a radius of eighteen miles from City Hall, even though a considerable part of this territory lies outside the city limits, and for this reason: from the point of view which concerns the telephone company the growth of places like the Oranges, Montclair and Yonkers is practically a growth of New York, and the residents of outlying districts who do business in New York and use a telephone at either end of the line are the same as residents of New York city. In smaller places the city line includes most, if not all, of the population associated with the city limit, but in New York this is not the case.

"Our calculations relative to the population within eighteen miles of City Hall produced these statistics: in 1870 it was 1,880,000; in 1880, 2,450,000, an increase of 30 5-10 per cent; in 1890, 3,278,000, a gain of 33 8-10 per cent; in 1900, 4,538,000, a gain of 38 45-100 per cent.

"In view of these statistics, and after consulting every available source of information, the telephone company made this forecast: within New York city and within a radius of eighteen miles from the City Hall there will be by the year 1920 a population of 9,000,000."

"What proportion of this 9,000,000 do you estimate will be the population of Greater New York?" the expert was asked.

"Our figures for Greater New York indicate a population of 5,900,000 by the year 1920.

"These estimates do not, however, agree with those obtained when the method of forecasting used by the Census Bureau is applied to New York city and its suburbs, and according to which the population in 1920 within the eighteen-mile area would be 7,000,000 and in Greater New York, 5,300,000.

"The difference in the two forecasts represents a problem which the engineers of the telephone company must confront. They must decide the question whether to plan for a population of 7,000,000 or of 9,000,000. If plans are made for 9,000,000 and only a 7,000,000 growth is attained a big error will have been made. In that event the telephone plant would be excessively large for the volume of business to be carried on and enormous losses would be incurred.

"On the other hand, if plans are made for 7,000,000 and a growth of 9,000,000 should be reached it would mean that the plant would not be sufficient to care for the business, necessitating a radical reconstruction and a wasteful expenditure of vast sums of money.

"No, there is no sure way to avoid such losses. The best that can be done is to make an exhaustive study of the situation and then go ahead.

"In view of the numerous fireproof buildings and costly switchboard systems which must be provided for the different central office districts it is obvious that not only must the population be correctly forecasted but also the number of persons who will require telephone service and their location. It is also necessary to predict with some degree of accuracy how many times a day these subscribers will be likely to call up the central office, and also the districts to which their calls will extend. In fact it is only by doing this that the trunk-line equipment and subway system necessary to join the various offices can be planned.

"For example, if the subscribers in the Harlem office should send the principal number of their calls to Broad street, it would naturally mean that in joining these offices there would be required a large number of underground ducts containing many trunk cables. If on the contrary the calls of the Harlem subscribers were principally to Jersey City the necessary duct and cable equipment should extend to that office rather than to Broad street.

"All of this must be determined in advance, as well as at what time of day most of these calls are likely to arise, for the operating force must be adequate to handle at all times a maximum number of calls.

"To one who has not studied the subject it would seem an utter impossibility to meet with any degree of precision these questions and many others even more refined and complicated. Nevertheless so far a fair degree of accuracy has been possible.

"In planning for the underground ducts which will be required between now and 1920 the engineers go into the matter exhaustively. They endeavor in all cases to put down at one time a number sufficient to meet the ultimate requirements, and in this way avoid unnecessary disturbance of the street and needless expenditure of big sums of money. Our underground duct system has already been extended to such a degree that there are now 295,000 miles of telephone wires on Manhattan Island, representing ninety-nine per cent of the total wire mileage. In this respect the showing made in New York is far ahead of that made by any other city in the world.

"A city commercially preeminent is bound to attract to itself business and people to proportions quite unknown to less important places; and that New York is the preeminent city of the United States no one disputes. The only thing which can check its growth is inadequate transportation facilities.

"Naturally if life becomes intolerably uncomfortable in a city the growth of population will be checked. Therefore in forecasting New York's population for 1920 the telephone engineers have carefully studied the effect upon the growth of the population of improved rapid transit and taken into consideration the opening of the subway and of the Williamsburg bridge, which they believe to be forerunners of many subways, bridges and tunnels.

"By 1920 their calculations, although not yet complete, indicate a provision for 1,000,000 telephone stations in the eighteen-mile area and 600,000 telephones in use in Manhattan, as against the 130,000 now used."

### *Annual Convention of the Ohio Independent Telephone Association.*

The annual convention of the Ohio Independent Telephone Association will be held in Columbus, Ohio, March 30. The members of the committee of arrangements are E. L. Barber, Wauseon; Cyrus Huling, Columbus; J. B. Hoge, Cleveland; Dwight E. Sapp, Mount Vernon, and Frank L. Beam, president of the association.

### *New York Electrical Society.*

The 249th meeting of the New York Electrical Society was held at 19 West Forty-fourth street, Wednesday, March 15.

In President Sprague's opening remarks, he referred to some experiments he had made ten years ago with an induction furnace for steel-making in New York city. These tests did not lead to any commercial result at that time. Dr. E. F. Roeber gave an address on "Recent Developments in the Electrometallurgy of Iron and Steel." Dr. Roeber dealt mainly with the manufacture of ferroalloys in the electric furnace and discussed especially those such as ferrotitanium, the manufacture of which requires a very high temperature which is not attainable in the blast furnace. For other alloys which are being made to some extent in blast furnaces (for instance, ferrosilicon) the electric furnace has the advantage of rendering obtainable high percentage alloys. Thus in the electric furnace ferrosilicon is made containing up to seventy-five per cent silicon, while the usual blast-furnace alloy contains only about fifteen per cent silicon. The speaker pointed out the advantages resulting to the steel men from the use of high-percentage alloys. He discussed at some length the different methods which are in use by different companies to produce alloys or metals free from carbon. A large number of alloys of considerable value were exhibited. Some of the most interesting specimens were received from the Goldschmidt Thermit Company, the Niagara Research Laboratories and the Roessler & Hasslacher Company. The use of ferroalloys in steel manufacture has brought about a revolution in recent years in the manufacture of special steels.

Dr. Paul L. T. Héroult spoke on "Making and Refining Steel in the Electric Furnace." He described the construction of his furnace, in which two electrodes are used dipping into a slag on the top of the molten metal. The current enters through one electrode, passes through the slag and the bath, and passes out again through the slag and the other electrode. By varying his artificial slag, he is able to remove all the usual harmful impurities, such as phosphorous and sulphur. The cost of power is insignificant, and the cost of the whole treatment in the electric furnace is below fifty cents per ton of steel if molten steel (from the Bessemer converter or the open hearth furnace) is introduced into the electric furnace. Dr. Héroult did not predict a revolution in the general metallurgical methods of steel-making, but foretold marked improvement in the quality of the steel used for various purposes.

An animated discussion followed in which Messrs. J. T. Moorehead, E. Stütz, L. Ruhl, Drs. Leonard Waldo and C. A. Doremus took part. Dr. Doremus spoke especially on the reduction of pig iron from ores and pointed out that it is simply a question of the relative cost of electric power and fuel. He showed, however, that there are other considerations to be taken into account, for instance, that it is not necessary to use a certain quality of coke in the electric furnace. Dr. Leonard Waldo gave some reminiscences of early electrometallurgical work done in this country, and spoke especially on Mr. Colby's and his own work with the induction furnace.

The following members were elected: Thomas A. Wilkinson, Henry McDonough, H. W. Appleton, F. W. Blasdale, Fred G. Gans, Hugo Fuchs, Stuart Hamill, G. A. Wells, Jr., Richard Lombard, Edward Taylor.

### *Iowa Telephone Association.*

The ninth annual meeting of the Iowa Telephone Association was held in the Chamberlain Hotel at Des Moines, March 14 to 16. The first session was held Tuesday, March 14, in the evening and was devoted to principally organizing.

President J. C. Sullivan, of Creston, read his address, reviewing in a measure the telephone situation in Iowa, and the great need of a closer relationship between the various operating companies in the state.

In the second session, Wednesday, March 15, a paper was read on "The Old Way and the New," by C. H. Judson, the consulting engineer of Council Bluffs. Mr. Judson's paper was in the nature of a brief history of the construction work done by telephone companies from the early days up to the present time, and closed with some remarks on modern all-cable, multiple-tap distribution. The next paper, "A Generator Call Lamp-Line Board," by Oscar Knell, of Perry, was a complete and interesting description of a board of this type installed by the Hawkeye Telephone Company in its Winterset office.

"The Relation That Should Exist between the Farmers' Mutual and Other Independent Telephone Companies" was discussed by C. A. Hollis, of Hudson.

The afternoon session was opened with a debate, "Magneto Multiple *versus* Central Energy Multiple Boards for Small or Medium-Sized Exchanges," by J. M. Plaster, of Fort Dodge, and R. S. Redman, of Newton. This subject and the discussion following it proved one of the most interesting features of the convention, for, although the majority of those who took part in the discussion preferred the central energy board, Mr. Plaster very able defended his side of the cause.

W. L. Barth, of the Sheldon School of Scientific Salesmanship, gave an address on the "Science of Modern Business Building," which was listened to with great interest.

"The Development of Toll Business and Checking of Tolls" was the subject of a paper presented by James H. Shoemaker, of Waterloo.

Thursday, March 16, the session opened with a very able paper on the "Iowa Assessment Law," by N. T. Guernsey, of Des Moines.

The next speech was delivered by James B. Hoge, of Cleveland, Ohio, and his subject was the "National-Interstate Telephone Association." Mr. Hoge explained the work of the Interstate association and the details of the organization and urged his hearers to join. Theodore Gary, of Macon, Mo., followed Mr. Hoge and spoke along the same line. Following these speeches, the association voted to join the National-Interstate association.

The election of officers then followed:

President, S. S. Lichty, Vinton.

Vice-president, P. C. Holdoegel, Rockwell City.

Secretary and treasurer, Charles C. Deering, Boone.

Executive committee—J. C. Sullivan, Creston; George N. Bandy, Des Moines; J. C. Thorne, Fairfield; J. S. Bellamy, Knoxville.

The afternoon was given to visiting the new exchange of the Mutual Telephone Company, and the exhibits and displays of the various manufacturers and supply men.

The banquet Thursday evening was held in the Chamberlain. The speakers were as follows: toastmaster, J. C. Hume, of Des Moines; "General Principles," Frank L. McGillan, Chicago; "The Telephone Troubler," J. H. Shoemaker, Waterloo; "A Square Deal, That's All," J. B. Hoge, Cleveland, Ohio; "Independent Telephone Men," Theodore Gary, Macon, Mo.

Charles E. Wells, of Marion, Kan., who was to have spoken on the Kansas Supreme Court decision, wired that owing to illness in his family he could not be present.

# Reviews of Current Engineering and Scientific Literature.

### *A New Train-Lighting System.*

At the recent Paris automobile show, several train-lighting systems were exhibited. In one of these a flyball governor, attached to the end of the armature shaft, actuates a rheostat arm, and in this way varies the field circuit. A more interesting system, however, is one in which a magneto generator is employed, in which the inherent regulation is sufficient to provide for all changes in speed. In a machine of this kind the intensity of the current is given by the formula $I = \frac{E}{\sqrt{R^2 + \omega^2 L^2}}$; that is to say, the current varies directly as the electromotive force, and inversely as the impedance. If the machine be constructed so as to reduce R to a negligible value, the current is inversely proportional to the reactance. But as the electromotive force and the reactance both vary directly as the speed, the current will remain constant, independent of the generator speed. While this condition can not be exactly maintained in practice, it can be approximated sufficiently for the satisfactory operation of lights. Since the supply is by means of alternating currents, the generator can not be used directly for charging the batteries which supply the lights while the car is standing. To get over this difficulty, the use of electrolytic rectifiers or other similar apparatus for charging the batteries is suggested.—*Translated and abstracted from L'Industrie Électrique (Paris), February 25.*

### *The Wear of Turbines.*

In this communication M. S. P. Yersin describes and shows photographs of a 200-horse-power turbine which exhibits a peculiar condition of wear. This turbine has been in use for six years. It is of the horizontal type, and drives two 100-horse-power generators, each supplying electrical energy to the city of Geneva. The water is supplied under a head of 135 metres to the outside of the wheel, and at this point the size of the jet is limited by a sliding vane. The jet itself is divided into several independent streams by blades in the nozzle. All the blades of the wheel have worn away in the same manner. The extreme ends of the blades are but little affected. Toward the centre there are three deep grooves cut entirely through the blades. The character of the wear indicates that it was not due to sand or foreign matter in the water, but to a peculiar action of the jet. This letter is discussed in another from M. J. Dalemont, who attributes the wear to eddies set up in the jet of water by the nozzle. He calls attention to a peculiar erosion of rocks which is sometimes observed, and which is due to the eddies set up in the stream. A remarkable case is illustrated, it being that which he has found at the bridge of Pon des Oulles on the Valserine river, two kilometres from Bellegrade. He thinks that the action of the nozzle and the distributor is to set the jet of water into harmonic vibration, producing, in this case, several nodes and loops. This would produce the wear which was found to have taken place. —*Translated and abstracted from L'Éclairage Électrique (Paris), February 25.*

### *Searchlight on Mount Hood.*

One of the striking features of the Lewis & Clark Exposition will be, according to Mr. F. L. Merrick, a powerful searchlight on the crest of Mount Hood, Wash. It is planned to place at this point an eighty-inch projector, which will be able from its commanding position to throw a beam 200 miles and illuminate the neighboring peaks. Mount Hood is 11,225 feet above the sea level, and is forty-six miles from Portland. The beam from this searchlight will light up Mount Rainier—100 miles from Mount Hood—and Mount Adams, and will be seen on a clear night by vessels 120 miles off the coast. To place the searchlight on Mount Hood requires a good deal of engineering skill and labor. It will cost about $30,000. A short tower of iron and wood, the upper part of the searchlight, and the base for the apparatus and operators will be built on the summit. The transmission line is to be built down the north side of the mountain to Cooper's Spur, and from there to a point in the neighborhood of Cloud Gap Inn, where a temporary generating plant will be installed. The difficult part of the undertaking will be the delivery of the necessary material and apparatus. It is proposed to overcome this by using a steel hoisting cable with sleds, and all of the material can be delivered on the summit by this means, as the side of the mountain toward Cloud Gap Inn is favorable to this mode of transportation. Part of the transmission line will have to be carried over glaciers, where special construction will be necessary. Iron poles, painted white, so as not to absorb any heat, will be placed in the ice to carry the cables. A flat surface on the summit of the mountain has been selected as the place for the tower. The foundations will be blasted out. The tower will consist of iron poles sunk in the ice, upon which the upper structure of iron, steel and wood will be constructed. To protect the operators from the severe cold of the mountain at night, the transformers and motors will be arranged so that they can be controlled from the operating room. After the sun goes down, everything on Mount Hood freezes solid. In addition to the searchlight effects from the summit, 100 arc lights will be distributed on the sides of the mountain facing Portland, and red fire will be employed during the exposition. It is said to produce a very startling effect. It is anticipated that this work may lead to the establishment of an astronomical observatory.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), March.*

### *The Future of Railways.*

In this section of his series of articles discussing the future of the British railways, Mr. Philip Dawson considers in detail the advantages which may be obtained by electrification. The principal one of these is the increased acceleration which may be secured. Another is the reduction in the dead weight. The electric train carries, in addition to the cars, only its motors. The steam train must carry its motors and its generating system. In the case of suburban trains, the locomotive, on the average, weighs over one-third the useful weight of the passenger coaches hauled. In an electric system the heavy locomotive is replaced by a comparatively light motor-car, and energy is generated under the most economical conditions at a central power station, from which it is transmitted many miles with but slight loss. The wear and tear on the track is reduced, not only by the use of lighter trains, but because the rolling and pitching which occur with steam locomotives are absent with the electric train. The fact that the motors are distributed through-

out the train still further tends to reduce the wear on the tracks. A larger proportion of the weight of the train is available for tractive effort with the electric drive, this being from twenty-five per cent to thirty per cent of the maximum load, while with steam locomotives it does not much exceed sixteen per cent. The cost of operating trains may be reduced, since fewer men are required to handle equivalent electric trains. Another important benefit will be the increase in the number of trains which can be handled in the termini. It is thought that an electric train will save at least four minutes at the termini of the five to seven minutes now taken by the steam trains. The author discusses the results of electrification, referring particularly to the conditions and performance of American systems, and lays some stress upon the increase in traffic which could be secured by electrification. This will mean not only an increase in the number of passengers carried, since it would build up the theatre and other traffics, but the faster time would induce people to live further away from London. A comparison of the cost of electric and steam operation is made, based upon the performance of the Mersey Railway. This shows a very decided gain for the electric service. The total working expenses with the steam trains were 82.4 cents per train-mile. With the electric service they were only 36.4 cents.—*Abstracted from the Electrical Review (London), March 3.*

### *Electric Power Supply in London.*

There are a number of bills now before Parliament which are concerned with the supplying of electrical energy to the city of London. The supply of electricity in London at the present time is partly in the hands of private companies, and partly in the hands of local authorities. Some of the private companies have been carried on most successfully and have developed a large and lucrative business. Others have not done so well. The municipal systems, on the other hand, can hardly be said to be thoroughly successful financially. An analysis of their accounts shows, as a rule, that, while the balance may appear to be on the right side at the end of each year, their reserve and depreciation funds have been starved in order to show that balance. In some cases it has been necessary to raise the rates in order to put the finances in a proper condition. The report of the London County Council, published last year, gives an analysis of all the accounts of London electricity undertakings for the year 1902-1903. Of the thirteen municipal undertakings, "only one was able to make a contribution for the alleviation of the rates, while four had to draw upon the rates, the net result being a call upon the rate-payers to the extent of £1,038." At the same time, only three of these undertakings paid anything at all to depreciation, the total reaching only £2,371. Four made payments to reserve fund, while one drew upon that fund, the result being an addition to the reserve fund of £15,390. This is wholly inadequate in relation to the heavy capital expenditures involved. The electrical supply companies in London, both private and municipal, are doing their best to secure a power load for their stations, as distinct from a lighting load, and create a demand for current in the day hours. In all cases the rates charged for power supply are considerably lower than those charged for lighting. One important phase of the development is the ever-increasing cost of land in central London. This makes the fixed charges in any undertaking heavy, and the burden, in some cases, becomes so great that the companies are seeking to obtain powers to erect their stations in outlying areas. It is for this purpose that the greater number of the bills now before Parliament have been introduced. If a power supply to London is to be carried on in the future by a large number of separate authorities, as is now the case, the process of the transfer of stations into less central districts must become even more pronounced. Two ways out of the difficulty are possible: each supply company may erect its own station in some convenient district removed from the centre of the city, or the smaller companies may purchase power from a large company which generates it on a much larger scale. It is thought that the time has now arrived for a full consideration of the question, whether the latter plan may not be of service to lighting authorities. In some cases this step has already been taken, two companies having agreed to make use of a joint station; but if more could combine and erect one large station, the result would be still more favorable. This way out of the difficulty should be followed by the municipal companies as well as by the private companies, but, at the present time, the municipal authorities are raising objections to every one of the private bills now before Parliament. These objections are merely obstructive, since in no case are the municipal authorities in a position to erect a large municipal station. The London County Council holds that it should be the authority for supplying electricity in bulk, although it could not itself carry out any such scheme for many years to come.—*Abstracted from Engineering (London), March 3.*

### *Wireless Telegraphy in England.*

Some details of the arrangement entered into by the British post-office authorities and the Marconi company are given in the *British Trade Review* for March 1. Last year, when a message was to be sent to a vessel, the British post office, which operates the land systems, would receive the message at any office and transmit it to the nearest Marconi station. It would collect a charge for the land service only, and it was therefore necessary for the receiver to pay for sending from the shore to the vessel.

On the first of the year this arrangement was changed. The post office will now receive messages at any office, and will collect the full charge. The message is then sent to a Marconi station, and transmitted to the vessel, the post office paying the Marconi company for its service. When a message is to be sent from a vessel to any land station, the Marconi representative on the vessel collects the full rate. The message is sent to the nearest Marconi station, and from here it is handed to the nearest postal telegraph office, the Marconi company paying the post-office charges. There has thus been established an exchange of traffic between the two systems, and persons who wish to send messages to any vessel can learn from the nearest post office the rates and the hours during which any vessel will be in touch with the Marconi stations. Many shore stations have been erected, which enable the Marconi company to keep in communication with any vessel for a considerable time. This arrangement greatly reduces the uncertainty of messages reaching the vessel for which it is intended. At the present time there are sixty ships fitted with Marconi apparatus, and sixty shore stations from which messages can be transmitted.

As regards the uncertainty of wireless telegraph messages, it is said that when the stations are fixed, such, for example, as between England and Amsterdam, messages are transmitted as regularly and as accurately as by any other telegraph system.

### *Meeting of the Electrical Section of the Franklin Institute.*

A meeting of the electrical section of the Franklin Institute was held at the Institute Building, Philadelphia, on the evening of March 16, 1905. The paper of the evening was entitled "Twenty-five Years of the Incandescent Lamp," and was presented by Mr. J. T. Marshall of the General Electric Lamp Works, Harrison, N. J. The paper was illustrated by lantern slides.

The history of manufacture of incandescent lamps from the early stages of the art down to the present time was given. At first all lamp bulbs were blown and no two had the same size or shape. The filaments were of split bamboo and were bent into hair-pin shape and carbonized. The various steps in the manufacture of the bamboo filament were shown, and the faults that developed in them were discussed. After the carbonized bamboo filament had been in use for some time a filament was developed, in which the bamboo was treated with a coating of asphalt. This proved unsatisfactory after a time and the present "squirted" filament was invented. This type of filament is made by pressing a compound through a small hole in a plate. Any amount of filament can be made in this manner, and it can be cut to the proper length to give a certain amount of light. One of the defects in the bamboo filaments was the fact that it was hard to get a length of over ten inches and that after a filament was once formed it could not be shortened.

The various processes followed in making the tube, through which the wires are led into the lamp, were also shown on the screen. In the early lamps four leading-in tubes were made from one piece of glass tubing. The tube was drawn down at each end and in the middle. It was then separated at the thin spot in the middle and two bulbs were blown in each piece between the drawn-down ends. The tube was then cut between the bulbs. The purpose of the bulb was to make a convenient spot for welding on the lamp bulb. The leading-in wires were next threaded through the tube and sealed in by heating the end of the tube and squeezing it with pinchers, and the filament attached. Then the tube was welded into the lamp bulb and the lamp was exhausted.

Platinum has always been used for the leading-in wire. In the first lamps the platinum wire extended entirely through the glass seal, copper wires being attached at the outer ends and the filament at the inner. The length of the platinum wires used was about one-half an inch. This made an expensive construction, and also one that was not very durable, as the platinum was apt to break at the point where it entered the glass. The next step was to shorten the length of the platinum wires to about one-eighth of an inch, and to use copper at each end of the platinum. Thus there were two joints entirely sealed in the glass, and the filament was attached to copper wire. The filament was fastened by bending the copper wire into a hook-shape, clamping it down on the filament and then copper-plating the joint. This construction, however, was somewhat unsatisfactory and changes were made. The present method of construction consists in attaching two copper wires to the platinum wires and sealing the platinum wires and the joint in the tube. The platinum wires project through the glass a short distance and the filament is attached to them by a kind of cement.

All the changes made in the lamp were usually accompanied by the substitution of machinery for hand-labor and also by a division of labor, one workman doing but one operation instead of three or four.

After the leading-in tube and the lamp bulb are welded the lamp is exhausted of air. This was originally done by means of a Sprengel air-pump and the time consumed was anything from one-half an hour to five hours. The results were not uniform with the air-pump however. Good lamps and poor lamps would be produced alternately, due to imperfections in the apparatus, and the bulb contained vapors of mercury. It was discovered that if a preparation of phosphorous was introduced into the bulb and heated, that when a certain point in the exhaustion was reached the preparation combined with the mercuric vapors and oxygen remaining in the bulb, and a practically perfect vacuum was secured. This discovery was embodied in the pumps, and uniform vacua are now obtained. The operator can easily tell when the proper vacuum is obtained, for the heating of the phosphorous preparation produces a blue haze which instantly changes to yellow when the proper degree of vacuum is reached.

The change in the pumps increased the production of a given number of operators. Formerly about four workmen attended to about one hundred pumps. Now each operator has a pump and can exhaust three lamps per minute.

After the lamps are exhausted they are tested for vacuum by means of an induction coil, and lamps which are imperfect will show the same effects as a Geissler tube. They are also tested for candle-power by comparing them with standard lamps in a photometer.

The various changes in the form of the base were shown on the screen. The earliest lamps had the wires soldered to the screw base and to a ring just above it. The various parts of the base were held together by plaster of Paris. The first change made was to place a small cap on the base and fasten one wire to that, the other wire still being attached to the screw portion of the lamp. In the earliest form of base with the ring there was a large circular projection of plaster of Paris around the ring. This projection was retained in the newer form as the moulded bulb had not been developed and the lamp was unsightly without it. When the moulded bulb was introduced the projection was dispensed with and the screw base was made flush with the bulb. The plaster of Paris filling was unsatisfactory, being somewhat hygroscopic and causing a leakage of current between the two wires when it had absorbed a certain amount of moisture. It was finally replaced with molten glass and porcelain.

It was pointed out that the number of parts of the earliest lamps and of the present lamps is exactly the same, with the exception of a small iron wire anchor which is used to help support the filament. This anchor is made necessary by reason of the increased length and the coil-shape of the present filament. Nor have any of the original parts been displaced and others substituted. Every piece that was in the original lamp is in the present one, although more or less modified.

At the conclusion of the paper Mr. W. J. Hammer called attention to the fact that the most remarkable thing about the incandescent lamp was the similarity of the earliest and present lamps. He stated that no other invention had undergone so many modifications without some part being either added or discarded or radically changed. He told of the work that was done before the time taken up in Mr. Marshall's paper (1880-1905) and discussed the difficulties of securing proper filaments. He also discussed the tests made on the very first lamps and said that, although the fall of efficiency of the lamps was known, its importance was not realized. He exhibited a photograph of a collection of lamps and parts of lamps he had made and which were exhibited at the St. Louis exposition. This collection shows every step in the development of the incandescent lamp from its inception, and is probably the most complete in existence.

In reply to a question regarding the substitution of nickel-steel for platinum in the leading-in wires, Mr. Marshall stated that it had been tried and, while in the main it had been satisfactory, enough failures in vacuum had developed with it as to make it unsafe for general use.

# INDUSTRIAL SECTION.

*ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.*

### *Changes in the Arnold Electric Power Station Company.*

Announcement is made of the change of the name of the Arnold Electric Power Station Company, of Chicago, Ill., to The Arnold Company. This company was organized in 1886 by its president, Mr. Bion J. Arnold, primarily to build electrical power plants. The scope of its work has greatly increased, until it now includes nearly all that pertains to electrical, civil and mechanical engineering. The company not only acts as consulting engineer for its clients, but it also maintains a complete construction organization capable of actually building the work it designs. At the same time, the company maintains a position independent of any connection with manufacturing companies, and is free to use the best make of apparatus suited to a given set of conditions. The company has well demonstrated its ability, both as consulting and construction engineer, in a number of installations, both in the electric railroad field, in the development of central stations, and in the equipment of modern shops for light, heat and power, air and steam.

One of the latest developments of the Arnold Company is the designing and building of complete hydroelectric plants. An installation of 3,000-kilowatt capacity for the Spring River Power Company is to be put in operation with a 33,000-volt transmission line from the water-power plant, at Lowell, Kan., to the lead and zinc mines in the vicinity of Joplin, Mo.

The company has recently increased its office space to accommodate this growing business, and now occupies suite 1536-1541 Marquette Building, Chicago. The officers of the company are Bion J. Arnold, president; W. L. Arnold, vice-president; Ralph G. Arnold, secretary and treasurer, and George A. Damon, managing engineer. A complete organization, consisting of competent civil, electrical and mechanical engineers, has been developed to handle the growing work of the company which will be carried on along the following lines: electric power stations, complete interurban railways, electrification of steam roads, shops and shop equipment, hydroelectric and transmission plants, investigation and reports, tests and inspections of electric properties, operating and modernizing, modern industrial plants.

From time to time, bulletins have been printed, descriptive of the technical features of various installations under the company's direction. These bulletins contain considerable engineering data, and have been very much in demand. A blueprint book, containing data of interest to the mechanical officials of steam railroads, has been compiled, and a set of blueprint maps showing the growth of the network of interurban electric roads in the western states, and indicating the relative sizes of the cities, as well as lines under construction and proposed, is kept up to date and furnished free to electric railroad officials.

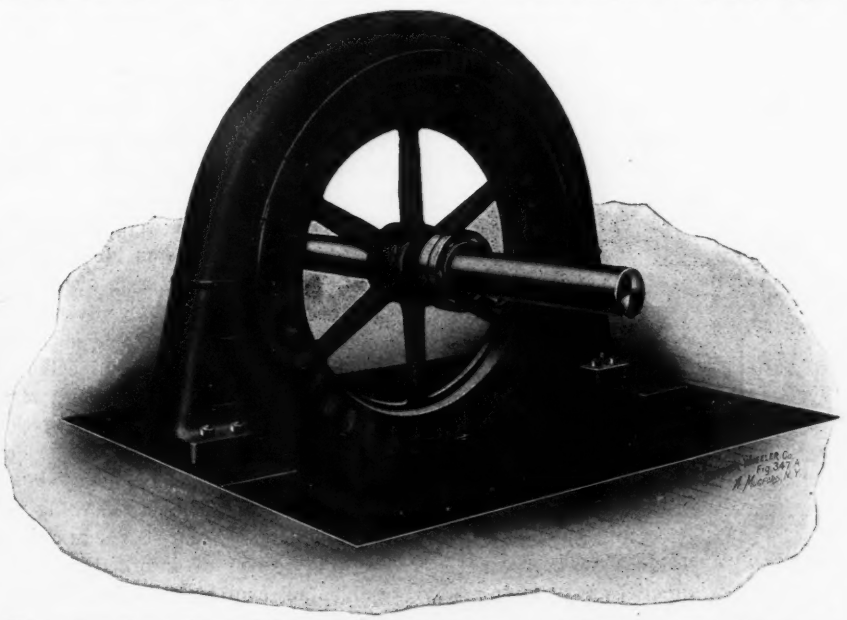
### *4,000-Kilowatt Alternators for the Chicago Sanitary District.*

An order for four 4,000-kilowatt, three-phase, sixty-cycle, 6,600-volt, alternating-current generators, with exciters, has been placed with the Crocker-Wheeler Company, Ampere, N. J., by the trustees of the Sanitary District, of Chicago, Ill. These are to be driven by Wellman-Seaver-Morgan horizontal water-wheels, and will be placed in operation at Lockport, Ill., the western end of the Chicago Sanitary and Ship canal.

The contract was awarded the Crocker-Wheeler Company, the American licensee of the celebrated alternating-current engineers, Brown, Boveri & Company, of Baden, Switzerland, in open competition. Mr. Gano S. Dunn, chief engineer; A. L. Doremus, secretary, and Julian Roe, Chicago manager of the Crocker-Wheeler Company, were active in securing the order.

Six years ago the Chicago Sanitary and Ship canal was opened and filled with water from lake Michigan. Since June, 1893, Mr. Isham Randolph, formerly president of the Western Engineering Association, has had in hand this project of tapping the great lakes at their southern end. His present work is centered at Lockport, where the mean head for water power developed when the present improvement is completed will be thirty-two feet, the net power being 40,000 horsepower. The ultimate discharge of the canal will be 800,000 cubic feet per minute. A structure of concrete and brick construction will house the power. Provision will be made for eight generator units, four of which are now under contract. The power generated at Lockport will be used for municipal lighting in Chicago.

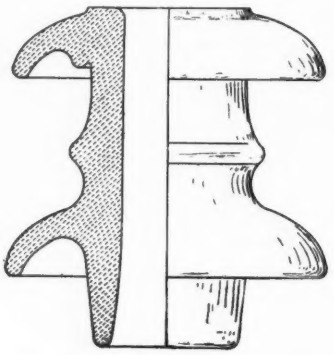
In this connection it is interesting to note that it is less than a year ago that the Crocker-Wheeler Company, long established in the field of direct-current manufacture, began to market a line of alternating-current generators for operation with every description of prime move. A recent notable contract was that for three 4,000-kilovolt-ampere, alternating-current generators to be driven by gas engines to supply current for the street railway system of San Francisco, Cal.



REVOLVING FIELD ENGINE TYPE ALTERNATOR—60-CYCLE, 220-VOLT, 3-PHASE, 200 R. P. M.

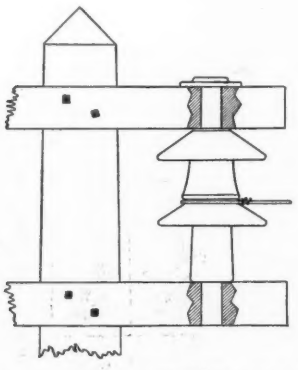
### *High-Tension Strain Insulators.*

The accompanying illustrations show two forms of high-tension strain insulator placed on the market by the Locke Insulator Manufacturing Company, of Victor, N. Y. The increase in the use of high-tension electric railroads will call for insulators capable of withstanding high mechanical and electric strains. The insulator shown is designated as the Victor No. 601 strain insulator, six inches high and five and three-quarters inches



HIGH-TENSION STRAIN INSULATOR.

in diameter, and has been designed for voltages as high as 8,000. The company has also developed a smaller strain insulator of the same general design for voltages of 5,000 and under. This design is very useful in the construction of spans for trolley suspension. The company is manufacturing a complete line of strain insulators for voltages up to 35,000, and



METHOD OF APPLYING HIGH-TENSION STRAIN INSULATOR.

is developing a new design which it will be able to manufacture for voltages of 60,000 or more.

As an indication of the mechanical strength of these insulators, the company reports that it has experimented with these designs considerably, and finds that its larger designs may be relied upon to stand a breakdown test of approximately 12,000 pounds, with the insulator supported by a pin passing through the middle, and the strain applied around the middle wire groove. In connection with these insulators the company has developed a method of using them, whereby almost any strain up to several tons may be applied with entire safety.

These insulators are used for dead-ending, curves or similar use in holding live wires of high voltage under excessive tension, the ordinary pin being too weak. The mechanical efficiency of the construction is apparent. The maximum strength of the pin is obtained. The pin is supported top and bottom, and the pull is transferred directly to the pole. The pin holes are all of largest diameter at top and bottom, having the smallest diameter directly opposite the wire groove, so that the porcelain is always under direct compression only, though the pin flex somewhat under varying loads.

A large line of insulators for all classes of service is described in "The Insulator Book," No. 8, recently issued by the Locke Insulator Manufacturing Company.

### *Quick Deliveries to Mexico from the Schenectady Works of the General Electric Company.*

In order to enable the Mexican Light and Power Company to effect temporary repairs to its generating station in the city of Mexico, which was recently partially destroyed by fire, two express shipments were made from Schenectady on February 8 and 11, which were remarkable both for their size and prompt despatch.

Telegraphic advices were received by the foreign department on Monday, February 6, stating that a large quantity of switchboard material would be required to enable the plant to resume operation, although at the time the full extent of the damage was not known. As a result of further telegrams, and consultations by telephone with the New York representatives of the customer, details of the order were settled Tuesday morning, and on Wednesday, February 8, the second day from the receipt of information of the trouble, an express shipment of thirty thousand pounds of switchboard instruments, switches and supplies left the Schenectady factory for Mexico City.

The shipment constituted a complete switchboard equipment for a 4,000-kilowatt power station, and to collect and despatch the material in this almost incredibly short time taxed every resource of the commercial, engineering and transportation departments of the company. While most of the instruments and switches were available at Schenectady, it was necessary to obtain instrument transformers by express from Lynn, and four large rheostats for generators of German make had to be entirely built from data telegraphed from Mexico. In addition a large quantity of wire and cable, which could not be supplied from the Schenectady stock, had to be borrowed from an installation which the General Electric Company was carrying out in New York city.

The transportation of the heavy reels of wire and cable through New York city for shipment to Schenectady was a task of great difficulty on account of the almost impassable conditions of the streets following a severe snow-storm. In handling the shipment from Schenectady, special arrangements were made with the railroad companies to obviate transshipments in passing from one system to another, and especially in crossing the Mexican frontier, and in addition a special messenger traveled with the car the entire distance to see that no delays occurred at junction points.

The shipment reached Mexico City on Tuesday, February 14, thus placing in the hands of the customer, within seven days from receipt of the first news of the disaster and from a factory over thirty-seven hundred miles away, a complete outfit of the new material necessary to restore the interrupted lighting and power service.

The fire also destroyed two engine-driven sets, imperatively demanding the immediate installation of two 500-kilowatt, Curtis steam turbine generators that were on order at the time, and one of which was due to arrive by freight in a few days. The second turbine had just been loaded on a freight car at the Schenectady factory, but the urgent need of the machine decided the customer to authorize its shipment by express.

Of this shipment the turbine proper, as boxed, weighed 27,000 pounds and occupied a space of eight feet high by eight feet wide by nine and one-half feet long. The doors of the ordinary express car would not admit the entrance of a package of these dimensions, but a special car having large doors was secured and by stripping the boxing to a minimum the loading was effected. The generator and other parts brought the weight up to nearly 43,000 pounds, making one of the heaviest single express shipments ever made.

The total weight of the entire shipments was 73,000 pounds, the express rate on which was over $8,200.

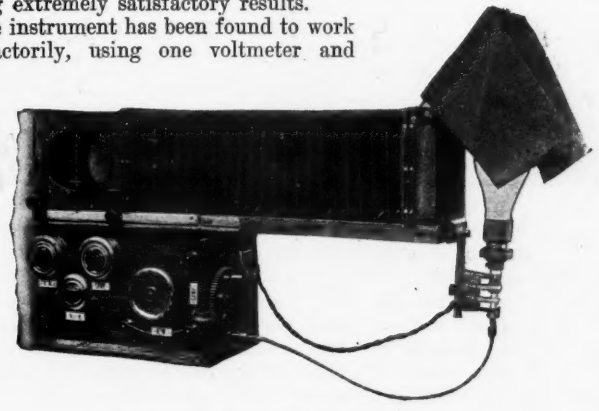
### *Portable Photometer.*

The instrument represented in the accompanying illustration is the well-known Queen portable photometer. A number of important improvements have recently been added to it, which simplify the method of the operation, and give more accurate results.

This photometer, as originally put out, met with decided success and is largely used for measuring the candle-power and efficiency of incandescent lamps. As so many incandescent lamps are now rated in mean horizontal candle-power, Queen & Company have recently added an attachment, by means of which the lamp being tested can be rotated; the device is simple and easily attached; and, as shown in the illustration, consists of a rotating socket connected by means of a flexible shaft to a pair of gear wheels, clamped to the side of the photometer case. The rotating motion given to the large wheel by the hand is multiplied several times and the lamp easily rotated at any desired speed. The device can be removed as there is sufficient room in the photometer case to allow it to be packed for transportation.

The use of the bellows on the photometer, shielding the scale from extraneous light, other than given by the lamps under test, has proved to be of great value, allowing the photometer to be used in a room with ordinary illumination, and securing extremely satisfactory results.

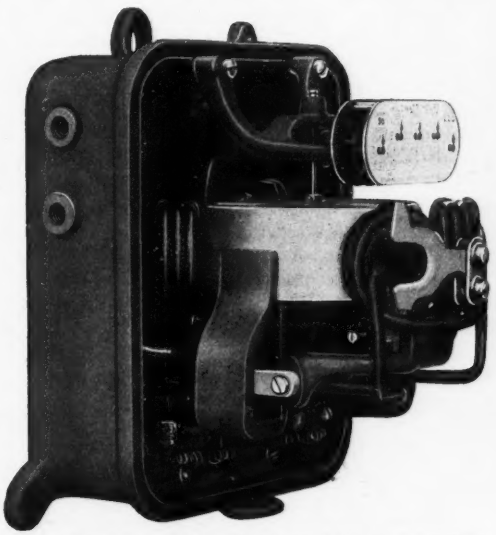
The instrument has been found to work satisfactorily, using one voltmeter and two rheostats, one for adjusting the current on the test lamp, while the other adjusts the current through the standard lamp. The scale is divided from four candle-power to fifty candle-power, which allows a range of measurements as wide as is necessary in practical work.



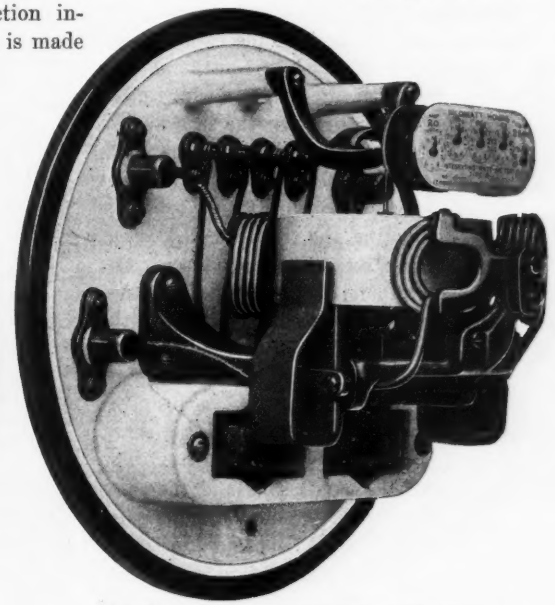
QUEEN PORTABLE PHOTOMETER.

### *Fort Wayne Integrating Wattmeters.*

The Fort Wayne Electric Works, Fort Wayne, Ind., manufactures the multiphase integrating wattmeter shown in the accompanying illustrations. This is known as the multiphase induction integrating type K wattmeter, and is made on the same general principles as the single-phase type K instrument. In addition to the features common to the single and multiphase wattmeters, the multiphase meter has the advantage of higher torque and complete registration of all energy in a multiphase circuit on a single-plate dial. This feature permits the use of a single multiphase meter in place of two single-phase meters on two or three-phase circuits. The working parts of the meter are supported on a cast-iron base, consisting of one piece. The base is provided with three lugs, for attaching the meter to the wall.



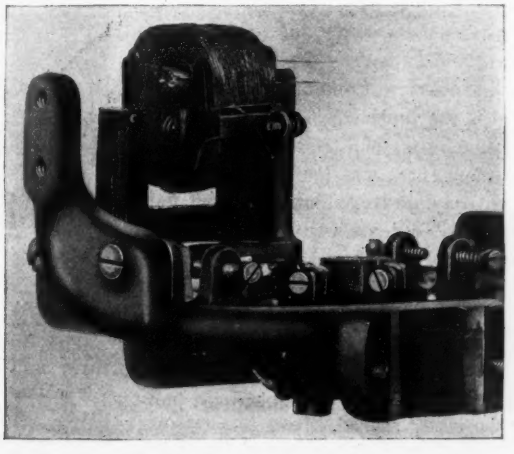
CASE REMOVED, TYPE K, FORM MAA, INDUCTION INTEGRATING WATTMETER.



CASE REMOVED, MULTIPHASE SWITCHBOARD WATTMETER.

The lower bearing consists of a flexibly mounted jewel enclosed in a vertically adjustable screw. By means of a cap screw, the shaft of the rotating element can be raised from the jewel, when necessary. The top bearing stud is simply a guide to the upper end of the shaft, and is rigidly mounted on the dial bracket. The lower bearing is immovable in the magnet bracket.

The retarding force is produced by two permanent magnets. These are mounted on either side of an aluminum cup on the lower bracket, and vertically adjustable in order to vary the drag on the cup. The registering mechanism is mounted in positive alignment on the dial bracket. A worm on the shaft meshes with a change gear which is mounted on a bracket on the back dial plate. The regis-



SHUNT COIL AND CORE, WITH LIGHT LOAD ADJUSTMENT.

tering dial gear is driven through this reducing gear.

Two sets of series coils—one on each side of a two-phase, four-wire, or two or three-phase, three-wire circuit—are mounted on arms screwed to the lower brackets. One pair is mounted back of the cup, and the other pair is mounted in front, and each pair is held in a brass spider which gives rigidity to the coils. In the larger sized meters strip copper is used in the coils, but the small capacity meters have wire-wound coils. Duplicate shunt coils are placed opposite and between the series coils of each set. The impedance coils, which correspond to the shunt armature coils, are placed in the bottom of the base, and covered with a cap secured with a bolt passing from the interior of the meter. The light load adjustment coil is on a movable arm inside the shunt armature coil and above the core. The position of the shunt coils and the cores is clearly shown in the accompanying figure. The revolving element consists of the aluminum cup heretofore mentioned.

These multiphase wattmeters are made in three, five, ten, twenty-five, fifty, seventy-five, 100 and 150-ampere capacities without current transformers, except above 600 volts. Larger capacities require current transformers. The standard voltages for which these meters are built are 110, 220, 550, 1,100 and 2,200, with frequencies of twenty-five, forty, sixty and 125-140 cycles.

### *Burke Electric Company—Fire Not Serious.*

On Friday, March 17, fire originating in the forge room destroyed the wing of the works of the Burke Electric Company, lessee of the Keystone Electric Company, at Erie, Pa., in which the finished storeroom for Keystone machines, blacksmith shop, punch department, etc., was housed. This wing was entirely destroyed and a large portion of the contents will be a total loss.

Fortunately, the dies and important fixtures were uninjured so that production will not be interfered with. Immediate steps were taken to ensure deliveries on all current orders, as well as to provide for prompt filling of future contracts. Plans for rebuilding the destroyed portion are being rushed.

The exact loss has not been determined, but appraisement is now in process. The loss will be fully covered by the insurance.

### *Winking Sign Specialties.*

The Phelps Company, Detroit, Mich., is manufacturing a number of winking sign specialties. These include self-flashing bulbs, the "Skedoodle" socket plug, the "Wynk" sign frame, the "Wynk" transparency, and the "Turnip" advertising bulb.

The self-flashing bulbs are made in two sizes, eight and sixteen candle-power, for any ordinary electric circuit between 100 and 120 volts. Each bulb is equipped with a Skedoodle, and operates independently of every other bulb. It is only necessary to screw in a self-flashing bulb and turn on the current. The winking apparatus turns the light up and down from the large to the baby filament.

The Skedoodle socket plug fits into any ordinary socket, and will hold a common bulb and wink it off and on several times a minute. They are made for four, eight or sixteen-candle-power lamps.

The Wynk sign frame is a ring sixteen inches in diameter inside, and twenty-two outside. The sockets are full size. A single winking apparatus on the back of the ring flashes on the eight bulbs altogether. The bulbs are two candle-power, and larger lamps can not be used unless specially ordered. The cardboard sign may be changed as often as desired.

The Wynk transparency is a plain box three and one-half inches deep, with a white frame in front holding a sheet of glass, celluloid or cardboard, nine by seventeen inches in size. Inside the box is one self-flashing bulb. This throws the light through the lettering, which may be made on ground glass, painted on plain glass, or used with perforated cardboard.

The Turnip advertising bulb is three and one-half inches in diameter, and has a winking device complete in the lamp base. There is also a spring which makes it possible to turn the reading right side up in the socket. The winking device turns the light on and off. These lamps, unless otherwise ordered, are furnished plain frosted. Ordinary paint or water color is used in decorating them.

### *A Thirty-five-Ton Induction Motor-Driven Crane.*

The traveling crane shown in the accompanying illustration has been operated almost continuously since March, 1904, during the erection of two 3,000-kilowatt Curtis turbine alternators, a 1,000-kilowatt motor-generator and other machinery in the main generating station of the Edison Illuminating Company, of Detroit, at Delray, Mich., March, 1904. It is equipped with General Electric induction motors and solenoid brakes.

The crane was built by the Northern Engineering Works, of Detroit, and is of the box girder type. It has a capacity of thirty-five tons normal, forty tons test load, and is equipped with an auxiliary hoist of five tons capacity. The span is thirty-three feet two inches and the length of lift twenty-nine feet six inches. All gears are of cast steel or forged steel and the high speed gears are enclosed. The electric equipment of the crane is General Electric Company form M, 220-volt, sixty-cycle, three-phase induction motors and controllers for the following horse-power and crane-speed ratings. Each motor is fitted with a standard General Electric alternating-current solenoid brake.

THIRTY-FIVE-TON CRANE, DRIVEN BY AN INDUCTION MOTOR.

| | Feet per Minute. | H. P. |
|---|---|---|
| Main hoist | 10 | 35 |
| Auxiliary hoist | 20 | 10 |
| Trolley | 100 | 6.5 |
| Bridge | 200 | 22 |

# CURRENT ELECTRICAL NEWS

## DOMESTIC AND EXPORT.

MONTREAL POWER STOCK—It is announced that a number of large holders of stock in the Montreal Light, Heat and Power Company, Montreal, Canada, have transferred to London capitalists 20,000 shares in that company, at the par value of $2,000,000.

THE GROWTH OF ELECTRIC LINES IN MICHIGAN—The Michigan state labor department has compiled some interesting statistics with regard to the growth of electric lines within the state. There are twenty-five different electric railways now being operated in Michigan, having 1,158 miles of single track. The capital stock of the roads is given as $34,000,000, of which $1,600,000 is preferred stock. The actual value of the roads approximates $45,000,000. During the year 151,001,029 passengers were carried, the sum of $6,581,275 being received for carrying passengers alone.

NEW LONG-DISTANCE INDEPENDENT TELEPHONE LINE—A long-distance independent telephone line has been completed between Cleveland, Ohio, and Buffalo, N. Y. This permits service between Cleveland and New York state points, including Rochester, Syracuse and other cities in the territory. The companies participating in the new service are the United States Telephone Company, of Cleveland; the United Telephone Company, of Pennsylvania, and the Frontier Telephone Company, of Buffalo, N. Y. There is now a network of long-distance wires running from Pittsburg, Pa., toward Philadelphia, and some long-distance construction in eastern Pennsylvania. From Columbus a line is being built to Dayton, and connection made with Indianapolis and St. Louis, extending these lines into Kansas City and to Texas.

NEW TELEPHONE COMPANY TO ABSORB NORTHERN IOWA LINES—A $1,000,000 telephone company, which is believed to have absorbed nearly all of the independent telephone companies of northern Iowa, has filed articles of incorporation with the secretary of state. The company is designated as the New State Telephone Company, with its principal office in Sioux City. The officers of the company are: president, Charles G. Cockerill, Jefferson; first vice-president, W. H. Leathers, Mapleton; second vice-president, Joseph Mattes, Odebolt; secretary, T. B. Lutz, Mapleton; treasurer, M. M. Head, Jefferson. The other directors are Ira Conger, Cherokee, and J. C. Hammond, Mapleton. According to the articles of incorporation, the company is authorized to transact a general telephone business in the state of Iowa, Minnesota, Nebraska, South Dakota, North Dakota, Kansas, Missouri and Illinois.

MEXICAN ELECTRICAL NOTES—Negotiations are in progress, it is stated, for the purchase of the Bermejillo interests in Guadalajara by an American company, for some $3,000,000. These interests include the mule traction street railways, the concession for an electric street railway system, an electric lighting plant and a large hydroelectric power plant at Juanacatlan, and a transmission line to Guadalajara. Should the deal for the transfer of the various properties and concessions not be consummated, it is understood that the present owners have made arrangements for securing the money necessary for the rebuilding and electrifying of the street railways, and that work will be commenced very soon. It is said that promoters are at work undertaking the building of an electric railway to run from Guadalajara to the port of Chamela. The Jalisco Exploration Company has been organized for the purpose of building the road. At a meeting of the stockholders of the Mexican Telephone Company, the plan to sell the property to the Mexican Telephone and Telegraph Company was approved. Holders of stock in the old company will receive new stock on a basis of one share of preferred and two shares of common for nine shares of the old stock.

## ELECTRIC LIGHTING.

NORFOLK, VA.—The Norfolk Railway and Light Company has awarded a contract of $100,000 for placing all of its electric lighting wires south of Queen street underground.

TEKAMAH, NEB.—At a special election for the issuance of bonds of the city of Tekamah, Neb., in the sum of $10,000, for the purpose of purchasing or installing an electric lighting plant, to be owned and operated by said city, the proposition carried by a vote of 136 to 82.

UNIONTOWN, ALA.—At a regular meeting of the Uniontown city council, a contract was closed with the Hardie, Fynes Manufacturing Company, of Birmingham, for a complete new electric plant outfit, to be installed as soon as possible.

MUSKOGEE, I. T.—The Grand River Power Company has been organized with a capital stock of $10,000. This is a preliminary organization to push the project of building a large dam and power station on Grand river, near Fort Gibson, to furnish electric power for factories in Muskogee and surrounding towns. Wagoner and Fort Gibson are also interested in the project.

SAULT STE. MARIE, MICH.—It is now assured that the Edison-Sault Electric Company will begin the improvement of its plant and the enlargement of the Chandler-Dunbar water-power canal as soon as the snow and ice disappear. The plans of the company are of much magnitude. A new power building equipped with the most modern machinery will be constructed.

SPRINGFIELD, NEV.—At the annual meeting of the stockholders of the Springfield Gas and Electric Company, directors for the year were chosen. They elected the following officers: F. W. Little, Peoria, Ill., president; E. B. Lewis, Chicago, vice-president; N. J. Cunningham, secretary and treasurer. P. A. Bertrand was appointed manager, and H. J. Fox, superintendent.

KNOXVILLE, TENN.—J. E. Durham, Philadelphia, and W. B. Cutter, of Buffalo, N. Y., have, through local counsel, petitioned the Bristol, Va., city council for an electric light franchise. The capitalists who are interested in the proposed erection of an electric power plant on the Holston river near Bristol, have been granted a franchise by the Bristol, Tenn., city council.

PORTLAND, ORE.—J. E. Jerome, W. J. Turner and J. H. Garrett, of Mountainhome, Ida., are organizing a company with capital stock of $500,000, and will build a power plant at Crane Falls, for the purpose of furnishing the towns of Mountainhome and Bruneau with electric power and light. The new company also contemplates the construction of an electric railway through a very fertile section known as the Bruneau valley.

CATASAUQUA, PA.—Among the improvements contemplated to the Lehigh-Northampton Gas and Electric Company, which is now in the hands of a receiver, are the following: one 300-horse-power boiler, one 250-kilowatt and one 150-kilowatt condensing engines, one condenser, one feed-water heater, one feed pump, one oil operator, two water generators, one 250-kilowatt direct-current and one 150-kilowatt direct-current switchboards.

TORONTO, ONT.—The Toronto city engineer has reported to the board of control that the estimated cost of installing a municipal electric lighting plant, with an alternating current sufficient to operate 1,500 arc lights, would be $638,000, which includes buildings, but not land. If power were obtained from Niagara Falls, the cost of lighting to the city would be $475,000. The estimate provides for placing the wires underground in certain districts.

CONNERSVILLE, IND.—George M. Sinks, receiver for the General Gas, Electric and Power plant, sold the property at public sale on March 9 to George B. Markle, of Hazleton, Pa., for $26,200. The property had been appraised at $42,000. Originally the company was composed of eastern capitalists. There was a first mortgage indebtedness of $75,000 on the plant, and stock to the extent of $300,000 more had been issued. Mr. Markle announces that he will spend a considerable sum of money in improvements.

NEWBURGH, N. Y.—An effort is being made to organize an electric light company to light Chester, Monroe, Central Valley and Highland Mills. The company will be affiliated with the Rockland Electric Company, of Hillburn, N. Y. The proposed capital is $30,000. The Rockland Electric Company is now furnishing about 1,200 horse-power, and expects soon to double the capacity of its plant. That company lights Hillburn, Suffern, Manwah, Allendale and Saddle River.

### ELECTRIC RAILWAYS.

BEDFORD, IND.—The work of surveying the line for the Bedford street railway, which will extend from Bedford to Oolitic, the quarry district, has begun.

WICHITA, KAN.—Work has been begun by the Wichita Street Car Company on improvements which, when entirely completed, will cost in the neighborhood of $15,000.

MONTREAL, QUE.—The by-law granting the Montreal Street Railway in Maisonneuve an extension of thirty years to its contract, expiring in 1924, or making fifty years in all, has been adopted.

MT. STERLING, KY.—It is reported that the recently incorporated Olympian Springs Company, of Lexington, will build an electric car line from the Chesapeake & Ohio road to West Liberty.

BLUFFTON, IND.—A proposed new interurban line, which is backed by Bluffton men, will run from Huntington to Celina, Ohio, by way of Bluffton. The line as proposed will not conflict with any other interurban line.

ANN ARBOR, MICH.—At a meeting of the common council, a franchise was granted to the Toledo, Ann Arbor & Detroit Railroad Company. The road is to be completed within twenty-one months or the company will forfeit $10,000 to the city.

ALTOONA, PA.—The Northern Cambria Street Railway Company is securing rights of way for a trolley line thirteen miles long from Patton, through Carrolltown and Spangler, to Barnesboro. W. H. Denllinger, of Patton, is president.

HARRISBURG, PA.—The Hummelstown & Campbellstown Street Railway Company will extend its system to Campbellstown. Its line at present runs from Hummelstown to Palmyra, a distance of eight miles. The cost is estimated at $225,000.

FITCHBURG, MASS.—A mortgage and note on real estate in Harvard to secure bonds to the amount of $100,000 have been recorded from the Leominster, Shirley & Ayer Street Railway Company, to the Boston Safe Deposit and Trust Company, trustee.

ROCKFORD, ILL.—The Aurora, De Kalb & Rockford Electric Company has sixteen miles of grading finished, which brings the line within a few miles of Maple Park. Two of the six bridges are completed. One is 140 feet long, and the other is 120 feet long.

WATERTOWN, N. Y.—An inspection has been made of the Rome road, from Carthage to Sackett's Harbor, with a view of equipping that road with electricity between the places named. It is more than probable that the thirty-mile stretch will be equipped shortly.

PASS CHRISTIAN, MISS.—The mayor and board of aldermen of Pass Christian have granted to J. T. Jones, of Gulfport, a franchise to construct and operate an electric car system over the streets of Pass Christian in connection with the proposed line from Biloxi and Gulfport.

DENNISON, OHIO—A project is under way, backed by Cadiz people, to build an electric line between Uhrichsville and Martin's Ferry, by way of Cadiz and Harrisville. Another line has been surveyed between Uhrichsville and Wheeling, by way of Stillwater, Freeport, Flushing and Holloway.

WASHINGTON C. H., OHIO—It is thought that a party of Columbus men and men living along the proposed line of the Springfield, Washington C. H. & Chillicothe traction line will arrange to lift the indebtedness of the line, now amounting to $110,000, and proceed with the construction of the road.

ONANCOCK, VA.—Capitalists have begun a movement to build an electric road from Onancock to Wachapreague by way of Onley, with a branch from Onley to Accomac Courthouse. The road will be about sixteen miles in length and connect the bayside with the seaside, running the breadth of the peninsula.

PLATTSBURG, N. Y.—The Schenectady Railway Company, which will extend its trolley line from Ballston Spa to Saratoga Springs, will build a belt line in the latter place. The company, it is stated, will shortly petition the Saratoga Springs authorities for franchises to lay tracks on several streets.

OMAHA, NEB.—J. S. Emerson, of St. James, Neb., has proposed to the Commercial Club, of Sioux City, the construction of an interurban line from Niobrara, Neb., to Sioux City. The towns along the line would be Sioux City, St. James, Wigant, Bow Valley, Crofton, Lime Grove, St. Peter, Daily and Niobrara.

REDDING, CAL.—A plan is being formulated in Redding to build an electric road from Redding to Kennet. The Northern California Power Company is to finance and construct the road and the business men of Redding are to subscribe for $30,000 worth of stock. The road will run direct from Redding to Kennet.

TACOMA, WASH.—Surveying parties are operating between Tacoma and American lake on the line of the proposed trolley road planned by Elmer J. Felt. It is said that a Philadelphia syndicate has purchased Felt's franchise and will construct the road, extending it on to Olympia and running a branch line to Chehalis and Centralia.

MANISTEE, MICH.—The Manistee, Filer City & East Lake Electric Railroad has been sold to Walter H. Trumbull, of Salem, Mass., representing the holders of the first mortgage bonds. A new corporation will probably be organized to manage the road. It is possible that the Sands electric lighting plant will be acquired and operated in connection with the road.

KANSAS CITY, MO.—G. B. Harrison, Sr., president of the Missouri Central Railroad Company, states that the work on the trolley trunk line between Kansas City and St. Louis will begin next spring. The cost of the line will be about $12,000,000. The proposed road will follow the Missouri river, crossing it twice, once near Glasgow and again just west of St. Charles.

SHARON, PA.—It is announced that the Sharon to Cleveland trolley line is to be pushed to rapid completion. The road will run from Sharon to Middlefield, Ohio, and there connect with the Cleveland & Eastern line. The company, which is composed of Cleveland and New York capitalists, has been successful in financing the road, and work is to be resumed next spring. The line will cost about $1,500,000, and will tap one of the richest farming communities in the state of Ohio.

WEST CHESTER, PA.—Permission has been granted to Thomas F. Bayard to sell, after giving five weeks' notice, the West Chester, Kennett & Wilmington Electric Railway, located within the boundaries of Delaware. The price must not be below $60,000. This line is the one built by the Vandegrift Construction Company and for which a receiver was appointed both in Delaware and Chester counties. It is understood that the portion of the line in Chester County will be sold later.

MERIDEN, CT.—The Consolidated Railway Company has completed the purchase of the control of the Hartford street railway, paying $285 cash a share for it, and for the East Hartford & Glastonbury Horse Railway Company's debenture bonds, which were guaranteed by the Hartford company and were convertible into its stock. The stock of the Hartford company is $1,000,000, and the East Hartford & Glastonbury bonds $200,000, so that the stock of the Hartford company is practically $1,200,000.

DAVENPORT, IOWA—The Iowa & Illinois Railway, an electric road, organized with a steam charter and running between Davenport and Clinton, Iowa, is nearly completed, and is being operated. The road runs a distance of thirty-six miles and has traffic agreements for passengers to Rock Island and Moline, Ill. The cost of building the road was about $1,260,000. The bonds are twenty-year five-per-cent first mortgage gold bonds, dated January 1, 1904, and due January 1, 1924. Of the total issue of $2,000,000 bonds, $950,000 are retained in the treasury. Of the authorized $1,575,000 in stock $1,500,000 is outstanding.

SIOUX CITY, IOWA—A new interurban line connecting Sioux City with Niobrara and intermediate points in Nebraska is projected. J. E. Emerson, of St. James, Neb., has interested a number of Sioux City men in the project. He declares that water power can be used, thus greatly reducing the expense of operation. There is a twenty-foot head of water near St. James which can be used, and a sixty-three-foot head of water in the Verdigris river further west. The line would pass through the following Nebraska towns: Dakota City, Hubbard, Allen, Daley, Bow Valley, Crofton and Niobrara. An engineer is to make a survey of the proposed line.

## PERSONAL MENTION.

MR. WILLIAM MARCONI, of wireless telegraph fame, was married on March 16, in London, England, to the Hon. Beatrice O'Brien, sister of Baron Inchiquin, in the Roman Catholic Church of St. George. A part of the honeymoon will be spent in Ireland, and the couple will sail for New York on March 25.

MR. W. A. STADELMAN has accepted the position of general eastern agent of the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, manufacturer of heavy machinery, cranes, etc. Mr. Stadelman has been for ten years past the eastern agent of the Brown Hoisting Machinery Company, and is very widely known in the machinery and electrical fields. His offices will be at 42 Broadway, New York city, beginning the first of next month.

MR. E. B. BOYE has been appointed manager of the Cleveland office of Manning, Maxwell & Moore, located in the Williamson Block. For the past five years Mr. Boye has been connected with the Chicago branch of the company. He is well versed and thoroughly posted on the various makes of machine tools and their uses. In his new position he will increase his large acquaintance among machine tool users, and his long experience in this line of business will help purchasers of the material in making careful selection of machine tools.

MR. CHARLES S. MELLEN, president of the New York, New Haven & Hartford Railroad Company, appeared before a legislative committee on March 14, in a hearing on a measure to compel the railroad company to make safe the third-rail electric line between Hartford and Bristol, running through New Britain, Newington and Forestville, Ct. President Mellen stated that the company had decided to abandon the third-rail service on July 1 next, and to operate the line entirely by steam; that the third-rail electric service has proved unprofitable, and would be given up.

MR. CHARLES D. KNIGHT has been appointed chief engineer of the American Electric and Controller Company, New York city. Mr. Knight was formerly connected with the engineering departments of the General Electric Company, Schenectady, N. Y., the National Electric Company, Milwaukee, Wis., and the Cutler-Hammer Manufacturing Company, of Milwaukee. Under his supervision the American Electric and Controller Company will manufacture, in addition to the "Rheocrat," a complete line of alternating and direct-current controllers, starters, automatic switches, solenoids, etc. Mr. Knight's headquarters will be at 12 Dey street, New York city.

MR. BION J. ARNOLD, the well-known consulting engineer, and member of the commission undertaking the electrification of the New York Central & Hudson River Railroad Company's lines, addressed the members of the Commercial Club, of Boston, Mass., on the evening of March 16. Mr. Arnold described the plans which had been completed for the two power-houses, of about 60,000 horsepower each. He described the equipment of the substations, and the characteristics of the generating and distributing service. He called attention to the contract which had been made for the electric locomotives, and the tests which are being undertaken to demonstrate the entire usefulness of this apparatus. He described in detail the improvements planned for the Grand Central Station, illustrating the address with numerous lantern slides.

## OBITUARY NOTICES.

MR. W. H. DURIN, of Cedar Rapids, Iowa, one of the most popular telephone men in the state, died last week. His funeral service was held at Cedar Rapids on Monday, March 20, and was largely attended by representative telephone men from various parts of Iowa.

MR. EDWARD C. COCKEY, superintendent of supplies of the Western Union Telegraph Company for a number of years, died at his home, No. 225 West 127th street, New York city, on Wednesday evening, March 15, at a quarter-past ten o'clock. Mr. Cockey was very widely and popularly known in telegraph circles. He was a former president of the Magnetic Club, and very prominent in numerous other societies. The funeral service was held in the Mount Morris Baptist Church, New York city, on Saturday evening, March 18, and the interment was in Kensico Cemetery on Sunday, March 19.

## ELECTRICAL SECURITIES.

The notable feature of last week's security market was the reactionary turn which came about and persisted more or less throughout each day's session. In many quarters, however, this reactionary development is held as a sign of strength, in that, although there was a considerable selling of the short interest, there is no evidence of a panicky condition, and it will prove a stop to any tendency to wildness in speculation. It must be understood that the stock market retrogression does not in any way reflect a similar condition in industrial circles. Notwithstanding the fall in prices of some securities, reports from every section of the country indicate a continued prosperity. It is a matter of fact that the market has been entirely indifferent to news incidents, even of the greatest importance. The poor showing for the last quarter by the United States Steel Corporation was expected, and it is freely predicted that in spite of this, there will be shown a record business for the whole year. The Northern Securities decision as a matter of financial interest is dwindling in importance, and it is now considered that it will be some time before any further effort is made to bring about a settlement of the ultimate ends of this dispute.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 18.

| *New York:* | *Closing.* |
|---|---|
| Brooklyn Rapid Transit | 67 |
| Consolidated Gas | 206 |
| General Electric | 188⅞ |
| Interborough Rapid Transit | 213 |
| Kings County Electric | 200 |
| Manhattan Elevated | 169¼ |
| Metropolitan Street Railway | 123¾ |
| New York & New Jersey Telephone Company | 174 |
| Westinghouse Manufacturing Company | 190 |

Directors of the Interborough Rapid Transit Company have declared a dividend of 1¾ per cent of the capital stock, payable April 4, to holders of voting trust certificates of record on March 20.

General Electric directors have declared the regular quarterly dividend of 2 per cent, payable April 15 to stockholders of record March 23.

| *Boston:* | *Closing.* |
|---|---|
| American Telephone and Telegraph | 144⅜ |
| Edison Electric Illuminating | 253 |
| Massachusetts Electric | 64½ |
| New England Telephone | 138 |
| Western Telephone and Telegraph preferred | 102 |

It is reported that earnings of the Massachusetts Electric Companies are making large gains over a year ago.

A dividend of $1.50 per share will be paid on April 15 to stockholders of record of the American Telephone and Telegraph Company at the close of business March 17. The instrument statement of the company for the month ended February 28 is as follows: gross output, 134,301; returned, 47,577; making the net output 86,724, compared with 47,309 for February, 1904. The total number of instruments now outstanding is 4,660,222. The annual meeting of the American Telephone company will be held in New York city, Tuesday, March 28, at twelve o'clock. Certain changes in the by-laws will be made, and stockholders will act upon the question of conveying certain lines to certain licensee companies.

| *Philadelphia:* | *Closing.* |
|---|---|
| Electric Company of America | 12 |
| Electric Storage Battery common | 85½ |
| Electric Storage Battery preferred | 85½ |
| Philadelphia Electric | 10½ |
| Philadelphia Rapid Transit | 30⅝ |
| United Gas Improvement | 115¼ |

The Electric Storage Battery Company's report for the year ended December 31, 1904, is as follows: gross, $1,344,536; expenses, $378,877; net, $965,659; other income, $117,249, making the total income $1,082,908; dividends, $812,435, leaving a surplus of $270,473, as compared with a surplus of $689,156 for the previous year, a deficit of $418,683. The following directors were reelected: P. A. B. Widener, Herbert Lloyd, G. D. Widener, Thomas Dolan, Grant B. Schley, H. P. Whitney, A. N. Brady, Thomas F. Ryan, Rudulph Ellis.

| *Chicago:* | *Closing.* |
|---|---|
| Chicago Telephone | 142 |
| Chicago Edison Light | 166 |
| Metropolitan Elevated preferred | 65 |
| National Carbon common | 45 |
| National Carbon preferred | 113 |
| Union Traction common | 12½ |
| Union Traction preferred | 47 |

### NEW INCORPORATIONS.

MAPLE LAKE, MINN.—Maple Lake Telephone Company. $10,000.

LEXINGTON, KY.—Central Kentucky Traction Company. $200,000.

CADIZ, OHIO—Cadiz Electric Company. $12,000. Incorporators: G. B. McGowan, G. D. McFadden, E. W. Long.

SACO, ME.—Saco River Power Company. $250,000. President, E. J. Jones, Everett; treasurer, J. O. Bradbury, Saco.

KITTERY, ME.—Eastern Telegraph and Stock Company. $100,000. Incorporators: H. Mitchell, M. G. Mitchell.

MILWAUKEE, WIS.—Union Light and Power Company. $5,000. Incorporators: A. G. Marks, Charles Tryon and L. B. Budd.

GREENTOWN, IND.—The Greentown Telephone Company. $30,000. Incorporators: J. M. Gleen, W. L. Bott, Art A. Largent.

EUGENE, ORE.—Bethel Telephone Company. $1,000. Incorporators: Mark T. Fleming, Charles K. Kompp and M. A. Bilgood.

DES MOINES, IOWA—Butler & Bremer Mutual Telephone Company, of Plainfield. $10,000. Incorporators: William Sinpan and others.

PERTH AMBOY, N. J.—Citizens' Electric Light, Heat and Power Company. $125,000. Incorporators: Jacob Goldsmith, Fred J. Cox, John K. Sheehy.

SALEM, ORE.—Klamath Light and Power Company, Klamath Falls. $4,000. Incorporators: Rufus S. Moore, Evan R. Reames, N. Baldwin and H. M. Gates.

NASHVILLE, TENN.—Corum Telephone Company. $5,000. Incorporators: J. J. McFarland, J. D. Carvey, J. J. Askew, J. R. Gwymme and W. H. Oldham.

PORTLAND, ME.—Western Water, Light and Traction Company. $10,000. Incorporators: J. W. Anderson, Gray; J. R. Parsons, Yarmouth; W. M. Bradley, Portland.

WILMINGTON, DEL.—Sumter Electric Light, Power, Railway and Telegraph Company. $100,000. Incorporators: J. L. Alnutt, Albert Dehaven, of Sumter, S. C., and others.

MONTGOMERY, ALA.—Long-Distance Telephone and Telegraph Company, of Decatur. $500,000. Incorporators: E. L. Barber, J. V. Monteith, J. C. Monteith and W. S. Isherwood.

WAPAKONETA, OHIO—New Knoxville Telephone Company. $8,750. Incorporators: A. H. Steinecker, George W. Holl, F. H. Fledderjohann, E. K. Meckstroth and George Wellman.

NEWARK, N. J.—The Citizens' Union Telephone Company. To construct telephone and telegraph lines. $150,000. Incorporators: Lester Park, Red Bank, N. J.; Edgar W. Danner, New York; Henry G. Beach, Newark, N. J.

COLUMBUS, OHIO—Ohio Bell Telephone Company. To establish an exchange in West Jefferson. $20,000. Incorporators: L. V. French, of West Jefferson; F. F. Dowds, F. H. Hutsberger and Jackson Underhill, of Mount Vernon.

LOGANSPORT, IND.—The Indianapolis & Chicago Air Line Traction Company. To build a direct line from Indianapolis to Chicago, passing through Jolietville, Kirklin, Michigantown, Flora, Rockfield, Idaville, Buffalo, Francesville, Crownpoint and Indiana Harbor. $100,000.

CLARKSBURG, W. VA.—West Fork & Valley River Railroad Company. To build and operate an electric line from Clarksburg and Grafton. $100,000. Incorporators: Gordon B. Late, Harry F. Armstrong and C. H. Warner, all of Bridgeport, and R. G. Altizer and Philip Steptoe, both of Clarksburg.

TRENTON, N. J.—The Edgewater & Hudson View Construction and Traction Company, Bull's Ferry Road and Palisade Plaza, Hudson Heights, N. J. To construct railroads. $100,000. Incorporators: August Sieber, Hudson Heights, N. J.; Thomas Karrigan, New York; William M. Schultz, West Hoboken, N. J.; Robert N. Sander, North Plainfield, N. J.; Thomas F. Prosser, Guttenburg, N. J.; William Dahm, North Bergen, N. J.; Charles A. Seiber.

### NEW PUBLICATIONS.

MEDINA AND ITS ELECTRIC POWER PLANT—The A. L. Swett Electric Light and Power Company, Medina, N. Y., has published a handsome bulletin descriptive of the industrial development of Medina, N. Y. The book is handsomely illustrated, and the descriptive matter is complete. The whole system of power plants, including water area and manufacturing sites, covers a total of 200 acres. The combined output of the power-house is 3,000 horse-power. The total head of water used is eighty-eight feet.

PROCEEDINGS OF THE CHAMBER OF DELEGATES OF THE INTERNATIONAL ELECTRICAL CONGRESS—The proceedings of the chamber of delegates appointed by the various governments to the International Electrical Congress, St. Louis, 1904, has been published. This includes the organization of the chamber of government delegates, the announcement of the official representatives appointed to the chamber of government delegates, the proceedings of the chamber of delegates, including minutes of the first, second, third and fourth meetings.

REGISTRATION OF TRADE-MARKS UNDER THE NEW TRADE-MARK ACT—This is a pamphlet by Mr. Arthur P. Greeley. The book points out the character and scope of the new trade-mark act, the purpose of the new act, the common law of trade-marks, and the requirements concerning registration. There is considerable misunderstanding and misapprehension in industrial manufacturing circles regarding the true interpretation of the new trade-mark act. All the difficulties likely to come up in the understanding of this act are taken up, and its possibilities carefully pointed out.

### EDUCATIONAL NOTES.

WORCESTER POLYTECHNIC INSTITUTE—The Journal of the Worcester Polytechnic Institute, Worcester, Mass., for March, contains, among a number of interesting articles, one by P. E. Barbour, discussing "The Distribution of Power-House Expense." Mr. Barbour shows how the expense of operating the boiler house and power plant should be distributed among the various departments, in order that each may bear its proper proportion of cost. The particular case considered is that of a copper smelting plant.

THE MICHIGAN COLLEGE OF MINES—The Michigan College of Mines will hold its second annual class-day exercises in Houghton and Hancock, on Saturday, May 5. The principal feature of the event will be the address by William G. Mather, of Cleveland, Ohio, president of the Cleveland-Cliffs Iron Company. The student body of the Michigan College of Mines at present averages approximately 200. The environment is a strictly mining atmosphere, and the principles of mining and metallurgy practised in the Lake Superior iron and copper mining districts represent the highest attainments in these lines of industry.

BULLETIN OF SYRACUSE UNIVERSITY—The Syracuse University, Syracuse, N. Y., has issued bulletin No. 4 of series 4, giving general information regarding the university. A short description of the city of Syracuse is given, and the various colleges and courses are described. The university has five colleges, namely: liberal arts, fine arts, law, medicine and applied science. In the college of applied science three courses are given—civil engineering, electrical engineering and mechanical engineering. There are accommodations for 1,200 students in the engineering courses. The bulletin is well illustrated with views of the city, campus and interiors of the various buildings.

LEHIGH UNIVERSITY REGISTER—The Register of Lehigh University, South Bethlehem, Pa., shows the attendance of 630 students from twenty-four states and eight foreign countries, the largest in the history of the institution. There are fifty-six in the teaching staff. Thirteen four-year courses of instruction are offered at the university: the classical course, the Latin-scientific course, the courses in civil, mechanical, marine, metallurgical, mining, electrical and chemical engineering, analytical chemistry, geology, physics, and electrometallurgy. Ninety-two students are taking the course in electrical engineering. A list of graduates of the university, with their present occupations, 1,399 in number, during the thirty-nine years of its existence, indicates that this institution is exerting a marked influence on the industrial development of the United States and of foreign countries. Provision is made for worthy and needy students, whereby they may postpone payment of tuition until after graduation.

### TELEPHONE AND TELEGRAPH.

ERIE, PA.—The Albion Telephone Company is extending its lines to Cherry Hill.

ANGOLA, N. Y.—The Evans Center telephone line has been extended to Angola.

YORK, PA.—The York Telephone Company is making extensive improvements between York and Red Lion.

NILES, OHIO—The Bell Telephone Company will extend its lines to Lordstown, Weatherfield and Newton.

SIOUX CITY, IOWA—The Iowa Telephone Company is planning the erection of a new exchange building in Sioux City during the coming summer.

NASHVILLE, ILL.—The Adieville Progressive Telephone Company has organized, electing L. W. Kokesh, president, George Doelling, secretary, and Emil Garlich, treasurer.

EMPORIA, KAN.—The farmers along upper Coal creek in Center township have organized a new telephone line that will extend from Emporia fourteen miles south and southwest.

CONNELLSVILLE, PA.—The Tri-State Telephone Company has enlarged its switchboards at Fairchance and Dawson, to make provision for a number of new subscribers in each of the towns.

NIAGARA FALLS, N. Y.—The Bell Telephone Company is making arrangements to extend its line north from Jeddo to accommodate many of the leading farmers along the county line.

EGG HARBOR CITY, N. J.—The Egg Harbor City Telephone Company is building a line to Gloucester Landing, a distance of five miles. This will connect the old town site with the new.

PINEVILLE, KY.—A new telephone company is being organized by prominent merchants and farmers of Bell County to connect heretofore isolated country districts with Pineville and Middlesboro.

PORTLAND, ORE.—The Estacada Telephone and Telegraph Company has secured a franchise in Estacada, and a contract has been entered into with the Pacific States Telephone Company, whereby each company may use the other's lines.

WHEELING, W. VA.—A large number of farmers living between St. Clairsville and Glencoe have organized a telephone company, and a system will be installed at once. The company will have a toll connection with the Belmont Telephone Company.

COLUMBUS, OHIO—The Cincinnati & Suburban Bell Telephone Company, Cincinnati, has filed a certificate with the secretary of state increasing its capital stock from $4,000,000 to $5,000,000. This is in accordance with a resolution of the directors passed on February 15.

BLOOMFIELD, IOWA—The Mid-Western Electric Company, of Cedar Rapids, has purchased the Davis County telephone system of W. J. Steckel. The buying company also owns the Moulton and Eldon systems and will make improvements and extensions. The consideration was $37,000.

PROVIDENCE, R. I.—The Providence Telephone Company has asked the general assembly to grant an amendment to its charter increasing the capital stock of the company to $5,000,000. The act was accompanied by a petition signed by Dexter B. Potter, president, and by Treasurer Howard.

ST. JOSEPH, MO.—Improvements, which will completely change the present methods of telephoning, are being made to the St. Joseph system of the Missouri & Kansas Telephone Company, at a cost of $200,000. The betterments to the company's properties include a new switchboard, which will accommodate 10,000 subscribers.

GLENWOOD, WIS.—The West Wisconsin Telephone Company has arranged to build a line from Glenwood through the town of Erie to connect with the Hammond independent lines, giving connection with all the independent lines of St. Croix and Pierce counties. This plan will give a second long-distance connection between Glenwood and St. Paul, Minneapolis and Duluth.

CUMBERLAND, MD.—Mayor King, of Cumberland, and Mayor Timanus, of Baltimore, on March 2 formally opened the long-distance telephone connection between Cumberland and Baltimore. The new line is 141 miles long and runs direct. The other lines have been placed to connect with Cumberland, Baltimore and intermediate towns. The opening of the new line gives communication between Philadelphia, Baltimore and Pittsburg.

ORANGE, TEX.—At the annual meeting of the Orange Telephone Company the following directors were elected for the new year: E. L. Bruce, A. L. Ford, A. M. H. Stark, R. H. Bruce, E. R. Webber and A. R. Webber, of Orange, Tex., J. W. Burnside, W. D. Dean and H. M. Shingle, of Kenton, Ohio. The directors then elected the following officers: E. L. Bruce, president; A. R. Webber, vice-president, and E. R. Webber, secretary-treasurer and manager.

TOWANDA, PA.—Fairview Independent Telephone Company has been organized with Daniel Boyce as president; L. C. Burroughs, secretary; I. V. Anderson, treasurer. Directors: L. C. Burroughs, Daniel Boyce and A. Fleming. The proposed line will extend down Granville creek to West Franklin, and there connect with the Canton & LeRoy Farmers' Telephone Company, thence to Burlington, and connect with the independent line coming from Smithfield.

NASHVILLE, ILL.—The Central Union Telephone Company, licensee of the American Bell Telephone Company in Illinois, has absorbed by purchase the entire holdings of the latter company in Washington County. The transfer includes the Nashville and Okawville exchanges and all toll lines. Owen M. Burgess, who was district manager, has resigned, and is succeeded by Edmund Robb, of Mount Vernon. The former has gone to Kansas City, Mo., to assume the vice-superintendency of construction of the Kansas-Missouri line, which embraces Missouri, with the exception of St. Louis, Kansas, Nebraska, Oklahoma and the Indian Territory. The Central Union proposes shortly to improve its entire system in Washington County.

RICHFIELD SPRINGS, N. Y.—At a meeting of the Otsego Home Telephone Company, held at the office of the Utica Home Telephone Company, the following officers were elected: president, H. A. Harrison, Utica; vice-president, George Whitman, Morris; secretary, John A. Losee, Richfield Springs; treasurer, T. Harvey Ferris, Utica; general manager, Charles H. Poole, Utica; engineer, Edward L. Cline, Utica; consulting engineer, F. C. Ward, Cooperstown. The Independent Securities Company, of Utica, recently incorporated with a capital of $800,000, and which is contemplating a $15,000,000 bond issue, has acquired a controlling interest in the Otsego Home Telephone Company and will back this concern in all its operations. The Otsego company now owns practically all of the independent lines in Otsego County.

### LEGAL NOTE.

COURT OF APPEALS UPHOLDS RIGHT OF INTERBOROUGH LINES IN THE BRONX—The Interborough Railway Company, of New York city, has secured a decision from the court of appeals, allowing it to construct six new lines in the borough of Bronx. The company originally made application to the state board of railroad commissioners, but this was denied on the ground that public convenience did not require the new lines, the territory being supplied with ample railroad facilities by the Union Railway Company. The appellate division reversed that decision and the court of appeals has affirmed the determination of the appellate division.

### NEW COMPANIES.

JERSEY CITY, N. J.—The Electric Heating and Equipment Company has been incorporated with a capital of $100,000, by Louis B. Dailey, H. O. Coughlan and Thomas F. Barrett.

STEUBENVILLE, OHIO—The Ohio Valley Electrical and Construction Company has been organized by H. P. McGowan, O. P. Swords and W. A. Gerber. It has a capital of $50,000.

PERTH AMBOY, N. J.—The Citizens' Electric Light, Heat and Power Company has been incorporated to manufacture machinery, apparatus, and equipment of all kinds for producing electricity. The capital is $125,000, and the incorporators are Jacob Goldsmith, F. J. Cox, John K. Sheehy, Louis Brieys, M. Goldberger, E. M. Kelly, A. P. Kennedy, G. T. Reynolds, C. A. Sexton, Henry McCollugh, C. D. Boynton, N. Roth, J. Goldberger, B. Goldman, Peter Floersch, John P. Hahn and Jesse Sickles.

## INDUSTRIAL ITEMS.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, is distributing a circular calling attention to "Transite" and asbestos fireproof lumber, which is used for fireproofing buildings.

THE NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., will be pleased to send its catalogue No. 40, describing vertical milling machines, to any one interested upon request.

THE BURKE ELECTRIC COMPANY, Erie, Pa., lessee of the Keystone Electric Company, has moved its New York office from 114 Liberty street to 26 Cortlandt street, where it has on exhibition some of the latest type motors. Mr. H. B. Coho is in charge of the eastern sales office.

THE CHURCHER ELECTRIC AND MANUFACTURING COMPANY, Cincinnati, Ohio, announces that Mr. W. B. Churcher has sold his rectifier patents to the Electrical Appliance Company, Cincinnati, Ohio. Mr. Churcher will manufacture the rectifiers, as heretofore, the Electrical Appliance Company being merely a selling organization, and assuming all the bills.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, has shipped, and expects to have running very soon, two motor equipments on large planers, one for the New York Central & Hudson River Railroad Company, and one for the Westinghouse Electric and Manufacturing Company. The company will be pleased to send full information regarding this apparatus upon request.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY, Cincinnati, Ohio, will be pleased to send its illustrated catalogue, descriptive of its patent head lathe. This is a quick-change-gear engine lathe with high-speed qualities. Numerous illustrations are given, showing the various features of this lathe. The lathe is easily adaptable to a motor drive, and illustrations are given, showing a motor-driven equipment.

THE SARCO COMPANY, 906 Sixth avenue, New York city, has prepared several attractive bulletins describing and illustrating its various specialties. As the name of this company signifies, this apparatus is claimed to "save a real cash value." A number of excellent devices for fixture work and decorative interior lighting have been produced by this enterprising company. These bulletins should be secured by any one interested in this kind of work.

THE WELLMAN-SEAVER-MORGAN COMPANY, Cleveland, Ohio, is distributing a new catalogue descriptive of Dewhurst patent slag ladles and cars. These appliances have been extensively adopted in leading plants in Great Britain, and elsewhere, with gratifying success. The catalogue describes the special features which this apparatus possesses. The cars are built side-tipping or end-tipping, as required. The company will furnish full details and submit proposals upon application.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester N. Y., has closed a contract with the Curtis Publishing Company, Philadelphia, Pa., for a central energy switchboard equipped with lamp line signals and double supervisory signals. This board is to be strictly modern in every respect. The company has equipped the new exchange of the Tri-State Telephone Company, of Grand Forks, S. D., which began service on January 27. Contracts have been closed for switchboards for the following places: Fairpont, Ohio; Illinois City, Ill.; Maple Lake, Minn.; Lathrop, Mo.; Granger, Tex.; Toledo, Ohio; Parnell, Iowa; Carmi, Ill., and Philadelphia, Pa.

THE COOPER HEWITT ELECTRIC COMPANY, New York city, has published bulletin No. 6, descriptive of new types of direct-current mercury vapor electric lamps for indoor illumination. Bulletin No. 7, dated February, 1905, describes in detail the mercury vapor electric lamp. This bulletin also gives a number of illustrations of installations of these lamps, which are being installed for general illumination and for photographic purposes with great success. A number of testimonials from prominent companies are published, attesting to the value of the light as a source of illumination. An important feature is displayed in the following quotation, taken from one of these commendatory letters: "We find that the strangeness of the light wears off in a very short time, and the draughtsmen, clerks and workmen are well pleased with the lamps. The light is very easy on the eyes, and owing to the splendid diffusion obtained, no dark shadows are caused, and the ability to see into and under objects by this light is surprisingly satisfactory."

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., reports that the large increase in the sales of "Okonite" and "Manson" tapes indicates a growing demand for these high-grade tapes. The company emphasizes the fact that these tapes are made only in one quality, the best, and that in order to make a perfect insulation all wire joints should be taped first with "Okonite," rubber tape and second with "Manson" friction tape. "Okonite" tape is thoroughly waterproof and a perfect insulating medium. It is not injured by exposure to weather, does not deteriorate when submitted to extreme changes in temperature, and is not affected by commercial acids or alkalies.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, reports recent sale of special laboratory generator to the Bliss Electrical School, Washington, D. C., and motors to the Massachusetts Institute of Technology, Boston. An installation of thirteen press motors has just been furnished A. I. Root, Incorporated, Omaha, Neb.; an equipment of generator and twelve motors for the School News at Taylorville, Ill. Among orders just secured are for equipping the plant of the Oil City, Pa., Derrick Publishing Company, with a generator and eleven motors; eleven motors for the printing house of Nitschke Brothers, Columbus, Ohio; S. Barker & Sons, printers and stationers, Cleveland, Ohio, six motors, and eleven linotype motors for the Manitoba *Free Press*, Winnipeg, Manitoba.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, announces that the Independent Telephone Company, at Topeka, Kan., has recently ordered a 1,200-line magneto-call switchboard system from it. The equipment consists of two sections, oak cabinets. Each position of this switchboard is fully equipped and arranged for giving service to 200 subscribers' lines. It is made possible to operate so many lines from one operator's position through an efficient training of the operators, and also owing to the equipment provided for handling the entire service throughout the board, the American company's flash-light transfer system having been adopted. The Independent Telephone Exchange, at Hot Springs, Ark., has recently had installed by the American Electric Telephone Company, of Chicago, an increase in its switchboard capacity to a total of 1,320 line terminals, this increase being brought up from 1,000 lines. Since the above installations, the American company has received an additional order for 180 lines, which presents a remarkable increase in the prosperity of the company.

THE ELECTRIC MOTOR AND EQUIPMENT COMPANY, Newark, N. J., engineered and successfully carried out the illumination of the dome of the capitol and the two sides of the shaft of the Washington Monument by means of searchlights, during the inauguration of President Roosevelt in Washington, D. C. Six eighteen-inch and four thirteen-inch government-type searchlight projectors, manufactured by the General Electric Company, were used to produce the illumination. These were located in the most advantageous places to produce the effect desired by the inaugural committee. One eighteen-inch projector was installed at the top of the Washington Monument, the light being directed toward the dome of the capitol, on which it was focused. About 1,500 feet from the monument, on top of the building of the Potomac Electric Power Company, there were located four eighteen-inch projectors. These were so placed and focused that, when the light was projected upon the monument, two sides were sufficiently and satisfactorily illuminated. Projected on the dome of the capitol were the rays from two thirteen-inch projectors, placed upon the roof of the building at the corner of Pennsylvania avenue and First street. These were about 1,200 feet away. At a like distance from the dome of the capitol, on a building on First street, near Maryland avenue, there were located two thirteen-inch projectors, whose rays were concentrated against the black-night sky, producing a very remarkable effect. Surmounting the dome is the tholus, at which place there was located an eighteen-inch projector, its rays directed toward the monument, producing a shaft of light extending a distance of a mile and a quarter across the city. The engineers were highly complimented upon their work by the inaugural committee.